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Popular Mechanics

**CLIMBING
THE IRON WAY**

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THAN AN AIRBUS A380

MEGA JET

TECH STUFF

- DIGITISE YOUR HOME MOVIES
- WHEN GADGET BATTERIES DIE
- RUNNING LOW ON DISC SPACE
- PIRATED MUSIC: A BIG DEAL?

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ANATOMY OF A
HOMEGROWN EYE
IN THE SKY





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WELCOME TO THE FUTURE. PREPARE FOR SOME INTERESTING SHOCKS.

Way back in 1970, futurist Alvin Toffler argued that the accelerated rate of technological and social change accompanying society's transition to a "super-industrial society" was leaving people disconnected, and suffering from stress and disorientation. In his eponymous, best-selling book, he defined "future shock" as a personal perception of too much change in too short a period of time. Interestingly, he popularised the term "information overload" long before the arrival of the Internet.

Where does this leave us? Are we vastly better informed than our parents*, or are we – as technophobes and especially jaundiced sceptics would have it – no better than aggregators of irrelevant and inconsequential scraps? Are we overwhelmed by a tsunami of information that shows no sign of letting up? If so, are we ignoring telltale cracks in our collective psyche?

It's all about choice, really, and if we take a little care, we won't lose the plot. Most of the information we want or need is out there; it's up to us to locate, filter, verify and use it to our best advantage. To simplify the process, it makes sense to identify a like-minded person or organisation to do the hard work for you – POPULAR MECHANICS, for example.

We do our best to provide a compelling mix of content spanning a broad range of interests – as spelled out by you in our regular audience surveys – and deliver that content across multiple channels. We cannot possibly give you everything you want, but at least we can steer you in the right direction.

Some examples: in this month's issue, we offer distinctly useful advice on freeing up computer disc space, comment on music piracy (yes, it remains ethically unsound) and tell you how to digitise your old home movies. Our cover story describes a huge aircraft, developed under a veil of secrecy, that's destined to launch a two-stage rocket into orbit (read about the Strato-launch project, starting on page 20). Will this change your life? Possibly not, at least in the immediate future. Do you need to know about it? Damn right you do.

In keeping with our policy of surprising (and hopefully, impressing) PM readers at every opportunity, we present a short essay on sexual conflict theory by David Buss, a professor of psychology at the University of Texas. Here's an extract: "Conversely, women sometimes present themselves as costless sexual opportunities, and then intercalate themselves into a man's mating mind to such a profound degree that he wakes up one morning and suddenly realises that he can't live without her – one version of the 'bait and switch' tactic in women's evolved arsenal."

Does this sort of thing belong in the pages of POPULAR MECHANICS? Hey, it's anthropology; of course it does.

Alan Duggan

aland@ramsaymedia.co.za

* Are we indeed better informed than our parents? Yes.

Calling all inventors – again

We are about to call for entries into the 2012 POPULAR MECHANICS Inventor of the Year competition, so if you have an invention that deserves attention, now's the time to get your act together.

In the coming weeks and months, we'll be providing details of the rules, categories, entry and other essential information, including an announcement about big prize money. See page 60.



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Associate editor Sean Woods gets a chance to burn some rubber around Kyalami race track, courtesy of Fantastic Racing, while attending a Nivea for Men product launch. Go figure.

COMPETITION WINNERS... Details online at www.popularmechanics.co.za

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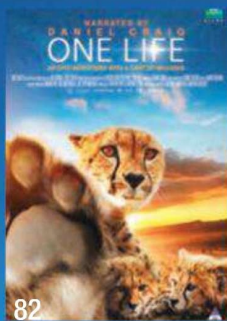
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On the cover: Designed by aeronautical genius Burt Rutan and backed by Microsoft co-founder Paul Allen, the world's largest plane will launch payloads – and eventually, astronauts – into orbit. Due to fly in 2015, the aircraft is rendered by Vladimir Shelest. **This page:** An artist's concept of the locally developed AHRLAC reconnaissance aircraft.





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38



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WIN

A desirable
Ford Focus worth
over R230 000
(see page 54)

WIN

One of two
DeWALT
contractors'
toolkits worth R15 000
(see page 95)





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Winning
letter

OKAY, SO LIFE IS DOOMED

Your article on the many ways in which civilised life on Earth could come to an end ("Game over?", March issue) sketches some terrifying and realistic scenarios. However, you might have added the fact that the sixth mass extinction of species in our planet's history is already under way – and no horror from the skies was needed to trigger it. Earth has been through five major extinctions, starting with the Ordovician-Silurian catastrophe that put an end to most of the brachiopods, conodonts and trilobites that inhabited the Earth 450 million years ago, and most recently the KT-event that culled the dinosaurs 65 million years ago.

However, in March last year, *Nature* published a study by Anthony Barnosky titled, "Has the Earth's sixth mass extinction already arrived?" His answer was yes, probably, and what makes this mass extinction so unlike the previous five is that life seems to be destroying itself.

One need only look at the figures: according to the WWF's biannual Living Planet report, the number of animals on Earth has decreased by 30 per cent since 1970. The WWF predicts ecological collapse by 2050. The UN's Global Diversity Outlook of 2006 confirms this and states: "In effect, we are currently responsible for the sixth major extinction event in the history of the Earth, the greatest since the dinosaur disappeared 65 million years ago."

Where Earth's natural extinction rate for species is about 30 a year, current estimates are that we have pushed it up to 300 a year. These figures are almost unprecedented outside a scenario of nuclear winter caused by a space rock impact or super-volcano eruption.

It would take no more than the destruction of a key group of species to collapse the food chain, and the environment with it. The ongoing decimation of pollinating bees in North America and Europe (due to pesticides, electric wiring and the globalisation of insect diseases) is just one of many indications that this could happen soon. Bee diseases such as foul brood, previously unknown in South Africa, have also been imported to the Western Cape in the last few years. Hopefully, when an extra-terrestrial intelligence visits our lifeless planet some day in the future, they might take a few lessons away from this. For us, though, it is probably already too late.

JOHANNES BERTUS DE VILLIERS
JOHANNESBURG

Write to us, engage us in debate, and you could win a cool prize; this month's best letter wins a desirable Luminox 0201 (Sentry 0200 series) watch worth R3 000. The Swiss-made Sentry Series is a vintage-inspired, cushion-shaped watch that's perfect for sporting and outdoor enthusiasts as well as real-life sentries on duty around the world. Among its key features: bold, oversized numbers on the even hours, Luminox Light Technology, reinforced polymer compound case, rotating bezel, water-resistant to 10 atmospheres. The Luminox watch is available from premium watch retailers nationwide. For more information, call: 011-486 6015.

Send your letter to: Popular Mechanics, PO Box 180, Howard Place 7450 or e-mail popularmechanics@ramsaymedia.co.za Please keep it short and to the point. Regrettably, prizes can be awarded only to South African residents.



No fat for wild birds, please

A hint on your back page titled "Eco-friendly bird food" (Do it your way", January issue) recommends feeding fat to wild birds. My wife, who has carried out considerable research on wild birds, says this is a very bad idea. Her comment: "Feeding fat to wild birds is unwise. Having rehabilitated wild birds for over 30 years, and done intensive dietary studies to find the best substitute food for captive birds, I've found that feeding them fat causes severe liver damage."

"The reason: our birds don't have the enzyme to break down cholesterol, whereas in the colder climates, where temperatures get to well below 5 degrees Celsius, the birds do have that enzyme. If you really want to encourage birds to visit your garden, put out some low-fat dog pellets soaked in water; it's far healthier. Or better still, start breeding your own colony of meal-worms."

LESLEY BENTLEY
VIA E-MAIL

Know your knots

I've just discovered a whole new world, and thought I would share it with you. At the beginning of the year, I set the goal of learning how to tie three useful knots. After researching the subject, and practicing for a week, I realized that three knots were not enough, and I decided to expand my repertoires. This pattern repeated itself, and after two months, I have settled on about 20 must-know knots.

Practical applications? Here's an example: after struggling for many years, I can now tie down a load on my bakkie securely and with as much tension as I wish, yet do so in a way that the knots are amazingly quick and easy to undo (I use a "trucker's hitch"). Employing a double or triple "sheet bend", I can join two pieces of rope of unequal thickness in such a way that the joined pieces are strong enough to tow a boat.

Just a few days ago, a friend and I abseiled to the ground from my apartment's balcony. The only kit we used for this adventure, aside from some 10 mm static rope, were two mini HMS carabiners (R190 each) and a set of garden gloves. We rigged up a belay line and had safety cords at the top for double redundancy at every point in the system. We made simple but effective harnesses using some rope and a few clever knots.

And then the fun began. The knots we used in our system included the "bowline with two-turns", the "figure-8 rethread", the "double figure-8" (aka "bunny ears"), the "alpine butterfly", the "double fisherman's", and finally, a wonderful little knot



It's about gravity, guys

The reader project featured in your March issue ("DIY load bed extension", Letters page) refers. The innovative plans conjured up by South Africans, of the "boer maak 'n plan" variety, are commendable and sometimes astounding. However, I feel PM should warn its readers of the danger incurred when shifting the centre of gravity backwards in a bakkie. In this case, it could significantly reduce the contact between the road and the vehicle's front wheels, causing it to drift; on corrugated dirt or wet roads, the consequences could be fatal. We should remember that a vehicle's centre of gravity is one of the main concerns of engineers when they design a vehicle.

EUGENE JANSEN VAN VUUREN
PRETORIA

Just fishing?

I have just read the letter by Travis J Carlson regarding his bakkie load bed extension, and I found it rather worrying. The manufacturer designed the vehicle to carry a certain load in a certain size of load bed. By extending that bed and placing weight further back in the vehicle, behind the rear axle, you might cause the vehicle to become unstable. However, Mr Carlson doesn't say what this extra space is used for. If it's just to accommodate an extra-long fishing rod, no problem, but if he's planning to toss in six bags of cement, oh dear...

DEREK WALKER
JOHANNESBURG

called the "Munter hitch", which allows you to abseil using only a piece of rope and an HMS carabiner.

I turn 31 this year and I want to kick myself for waiting this long to learn a few useful knots.

FRANCOIS VILJOEN
VIA E-MAIL

Signs of life

There are many reported cases of elderly and infirm people living on their own, with

infrequent visits from relatives, suffering a fatal stroke or heart attack. Tragically, their bodies are discovered by chance only after days or weeks have gone by. Surely someone could develop a microchip implant that could send text messages to pre-selected cellphone numbers if the life signs should cease?

ALBY VAN ZYL
KRUGERSDORP

In hot water

The article titled "Boiling point" (Car Clinic, March issue) refers. You offer some valid causes for overheating problems when a car is stuck in traffic, but you failed to mention some other, very common causes: failure of the thermostat, failure of the electrical circuit that controls the cooling fans, and failure of the fans themselves. That said, many thanks for an excellent publication.

DAVE BACHE
SOMERSET WEST

Great car, but what's the point?

I was fascinated by your article on the McLaren MP4-12C ("Pulse of a supercar", December 2011). I have been a rabid sportscar and motorsport enthusiast since the early Fifties. As such, I could relate entirely to the superlatives that rolled off your pen as you described the sensations experienced during your session with this remarkable car.

It bristles with examples of the most sophisticated technology available. What's more, it achieves a staggering level of performance, including a maximum speed in the region of 330 km/h, all of which prompts my question: What is the point of it all? How many places are there in the world where one can drive at the speeds mentioned, considering that speeds on most of the world's roads and highways are limited to about one-third of this car's maximum? And how many people are capable of handling performance at this level?

ALAN CHOWLES
BRACKENFELL

Give credit where it's due

Having just read a back issue of PM that I missed earlier this year ("101 gadgets that changed your world", August 2011), I must point out an error relating to the invention of radio. This is credited to Marconi – a common error. In fact, Nikola Tesla invented the first working wireless, even though the find was credited to the Italian. After

lengthy court battles, the patent was eventually placed in Tesla's name. Tesla was a fascinating and quite brilliant inventor, if somewhat eccentric. His theory regarding wireless electricity is one that still fascinates me today.

ADRIAN EDWARDS
VIA E-MAIL

Editor's note: Actually, our article stated that radio was patented (not invented) by Marconi, "who based his work on technology developed by Nikola Tesla". For the most succinct account of what happened, visit this site: <http://to.pbs.org/14wwwZM>

Ghosts ain't heavy

In your Feb 2012 issue, you published an article on Jimmy Leeward's fatal crash in 2011.

You refer to the "6-ton World War II P-51D fighter" plummeting into the crowd. My problem is with the stated weight of the plane: operationally loaded, the P51D Mustang should weigh only 3 465 kg, or 4 175 kg with a full complement of ammunition and fuel – which is still far off 6 tons.

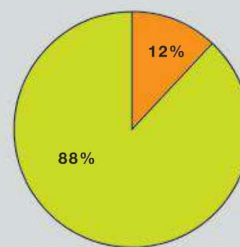
I know that The Galloping Ghost was a P51D-15-NA, and that aside from having about 3 m clipped from the wingspan, the previous owners (including Leeward) reduced a lot of weight in a bid for higher low-level speed. I thus find it highly unlikely that his plane could have weighed 6 tons on the day of the incident. Regardless, I love your mag.

ENSLIN VAN NIEKERK
PRETORIA PM

MONTHLY POLL

Do you think the world will end in 2012?

- Yes. There are many prophetic signs that the world is coming to an end – earthquakes, war, you name it. 12%
- No. According to real scientific evidence, the world will not end in 2012. 88%



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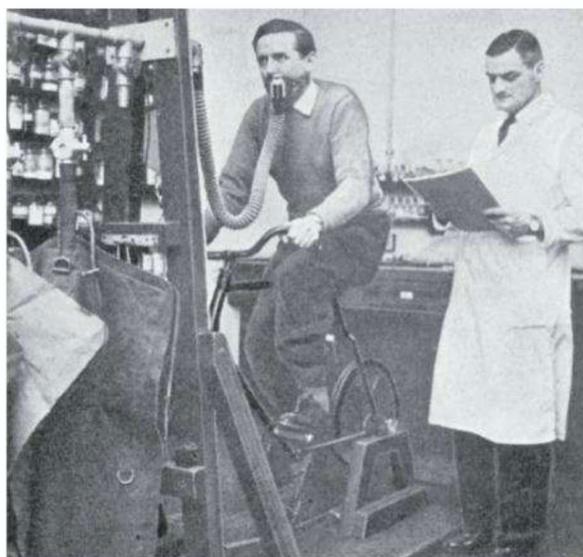
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Don Russo, Phila., Pa.

Admired Since He Gained 12 lbs.
"After losing weight and pep, I gained 12 lbs. and was full of pep. Everybody admires my pictures, too."
Ralph Laefler, Arlington, Wash.

IMPORTANT
Beware of Substitutes

1939 Back in the day, judging by this advertisement, a skinny physique was a sure recipe for failure – especially when it came to women. All it took to cure this awful affliction was a bottle of “ironised yeast” tablets. As one happy customer revealed: “My new huskiness and pep has brought me lots of new friends, too.”



1959 Preparing for human-powered flight, Dr WR Wilkie of the University College of London (the man coupled to the weird-looking machine) helps aviation scientists to determine the amount of power that could be produced by a man pedalling a bicycle. The first officially authenticated take-off and landing was achieved by Briton Derek Piggott on 9 November 1961. Seated aboard a fragile aircraft called Sumpac, he lifted off for a flight of 64 m at an altitude of just 1,8 metres.

Build Our 25-Foot Houseboat for \$1000 Page 158

JAN. 1969
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POPULAR MECHANICS

SPECIAL MIDWINTER **CAR ISSUE** 36 Pages

The Wood Bros: Can They Win Again at Riverside?
Comparing Those Sporty Small Sedans:
Datsun, BMW, Cortina, Saab, Fiat 124
Luxurious New Pickups

Styling:
Why U.S. Cars Look Alike
Dan Gurney's Column
Auto Clinic

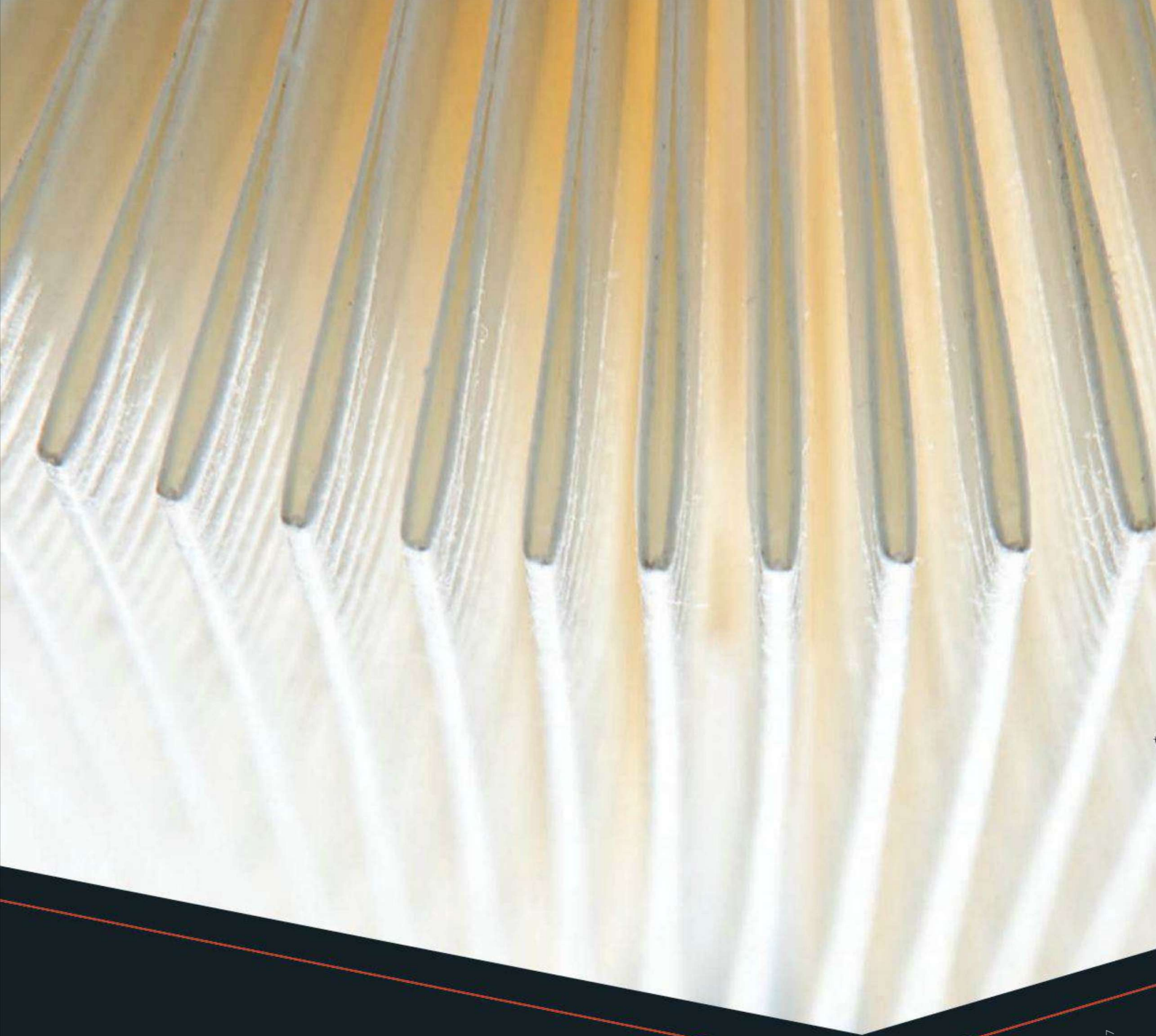
STARLIGHT SCOPE
The Story Behind Our New See-in-the-Dark Gunsight

HOW TO: Build Game Storage Under a Pool Table ■ Hop Up a Snowmobile ■ Install Trim Tabs to Make Your Boat Ride Better ■ Amplify Your Telephone ■ Adjust Garage Doors ■ Give Your Wife More Storage in the Kitchen ■ Build an 'Antique' Clock ■ Put a Sink in Your Darkroom ■ Mill on a Drill Press ■ Make a Stand for Your Shop Tools ■ Replace Ignition Wiring (Saturday Mechanic)

1969 This month's rather busy cover showcased the Starlight scope, a “super-secret” gun scope than reportedly intensified images up to 50 000 times and equipped American soldiers with daylight vision in pitch darkness. Since our illustrated article described exactly how it worked, we presume the super-secret appellation became null and void.



1948 A rare excursion into the world of fashion produced this little gem about “fashion spies” who capture style secrets at shows with the help of tiny cameras hidden in handbags and even the soles of shoes (the shutter release button was secreted in the spy's pocket). The idea, we're told, was to copy the designs and make knock-offs. Nothing changes... PM



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Nasa's Earth Observing-1 satellite captured this image of a newborn island on 7 January. It's a healthy 500 metres across.

■ ACTIVE PLANET

Congratulations, it's an isle!

The eruption started on 19 December, with local fishermen off the western coast of Yemen gaping at 30-metre fountains of surging basaltic magma. A few days later, when the lava had cooled, there was a new landmass in the Red Sea. Situated in the Zubair Group of islands, the newest addition to the world atlas lies at the border of the African and Arabian tectonic plates. As the plates pull apart, they cause the formation of new ocean crust. Don't start making new maps just yet: American Museum of Natural History volcanologist Jim Webster says that the odds are good the island will survive, but there's no guarantee. "It's always a competition between land formation and erosion from wind and water," he says. — ALEX HUTCHINSON

DID YOU KNOW: Sixty-five per cent of the lava that makes it to the surface of the planet erupts not on land, but on the ocean floor.

■ BIOLOGICAL RECORD-BREAKER

Tiny frog makes a big splash

Chris Austin knew he had stumbled upon something big – well, important – when he found a new species of frog, *Paedophryne amauensis*, under a bed of moist leaves in Papua New Guinea. Austin, an associate professor of biological sciences at Louisiana State University, followed a chirping noise to its source, where he discovered the world's smallest vertebrate. The frog measures less than a centimetre, so its existence contradicts a theory that such diminutive creatures need to be immersed in water to keep their bodies from desiccating.

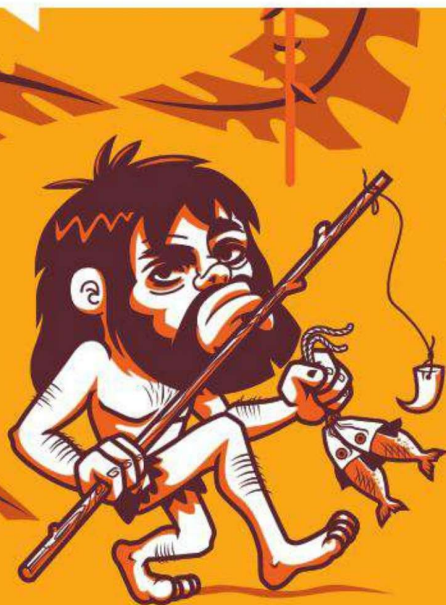


■ ANCIENT MYSTERIES

Rise of the fishermen

AN ANCIENT DISCOVERY FORCES A RE-EXAMINATION OF MANKIND'S RELATIONSHIP WITH THE SEA.

BY STEVE ROUSSEAU



Archaeologists in East Timor have unearthed the world's oldest fishhook, a discovery that may change scientists' understanding of ancient man's technological prowess. Australian National University archaeologist Sue O'Connor found the hook, made of shell and used at least 16 000 years ago. That predates the previous known existence of angling by 10 500 years. O'Connor's search also yielded bones of deep-sea prey such as tuna, rays and sharks caught up to 42 000 years ago – the oldest known evidence of deep-sea fishing on the planet. The finds appear to dispel a previously held theory that Pleistocene-era humans were merely opportunists who scavenged shallow-water game. "Fishing has always been one of those things thought of as requiring complex skills," O'Connor says.

Man vs fish:

A TIMELINE OF TOOLS

SPEAR

A bone harpoon point found in central Africa next to the bones of giant catfish pegs the first spearfishing at roughly 85 000 years ago.



NET

Bones of deep-sea fish found at prehistoric sites suggest humans used nets – now decomposed – more than 42 000 years ago.



HOOK

The oldest shell hook is at least 16 000 years old – but scientist Sue O'Connor says hooks could have been used up to 23 000 years ago.



GORGE

Evidence of gorges – sharpened pieces of bone or stone tied to a line – dates back 12 000 years, but their use in fishing is certainly older.



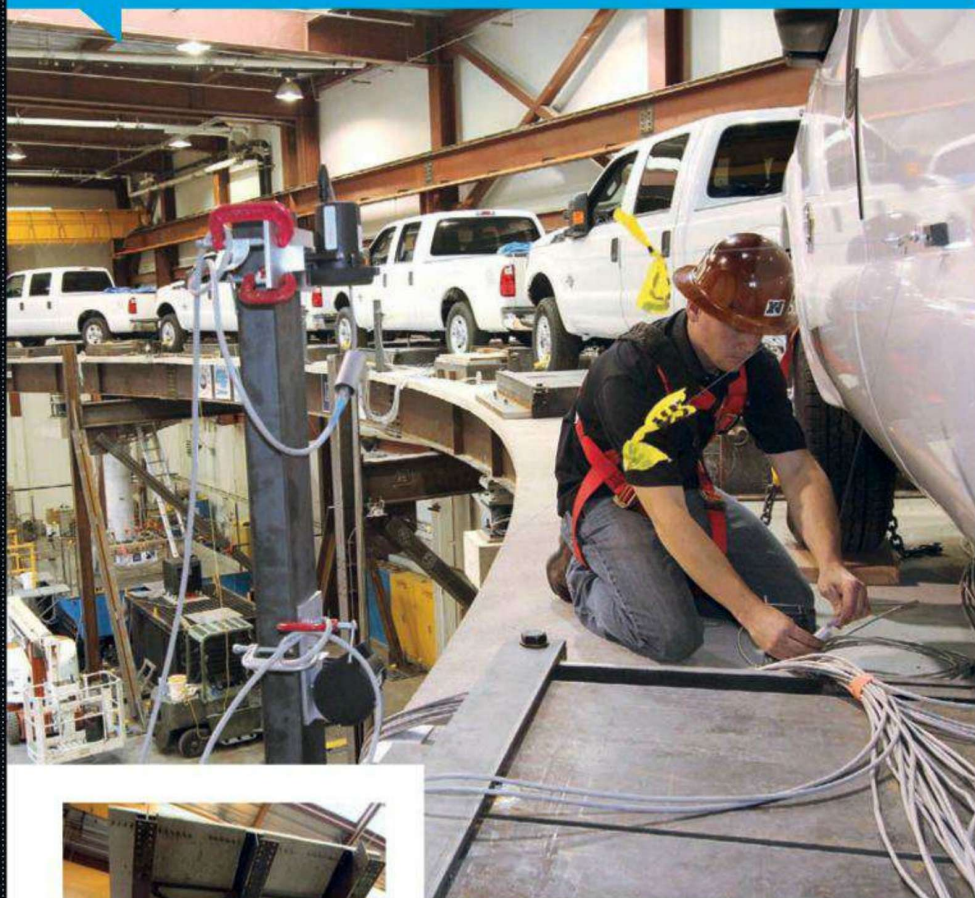
BARBED HOOK

Hooks adapted to snag a fish's mouth emerged roughly 6 000 years ago. This design has remained the same into the modern age.





INFRASTRUCTURE



The shake table's 400 sensors measure the integrity of building materials.

Bridge shakes

➡ Civil engineers at the University of Nevada injected a new level of realism into seismic testing, linking four shake tables to erect a 44-metre-long, 147-ton steel and concrete bridge in their lab. The coup de grâce: loading the tables with full-sized vehicles to explore the controversial question of how heavy traffic affects bridge stability. Researchers ramped up the tremors to more than twice the strength of a 1994 US quake measuring 6.7. The initial results suggest traffic can be a blessing and a curse. The trucks' weight helped the bridge withstand smaller quakes, but made it more vulnerable in larger ones. – ALEX HUTCHINSON



PLANETARY MATH

Our uneven axis

Earth rotates every 24 hours around an imaginary line that runs through the North and South poles. Gravitational pull caused by the Sun and Moon and the planet's orbit, causes the axis to shift – but no one had ever measured it directly. To calculate this planetary wobble, researchers in Germany shone two lasers in opposite directions around a 4 metre-wide square loop buried 6 metres underground. The planet's rotation means that the laser has to travel slightly farther in one direction than the other; the resultant change in the beams' frequencies reveals the wobble. The results: Earth's axis drifts every 435 days by as much as 6 metres.

Photographs by Mike Wolterbeek



QUICK HITS



Flu crystal ball ➡ Emergency-room doctors need to know when they're about to be swamped by a flood of flu patients. According to a new study from Johns Hopkins and George Washington universities, they should turn to Google's Flu Trends tool, which tracks the frequency of 45 flu-related search queries to offer daily estimates of how bad the flu is in a given place at a given time. Previous studies have shown that Flu Trends data match up well with that collected by official disease control organisations. The problem with the official data is that it takes weeks to reach doctors on the front lines. The study is the first to demonstrate that Google data actually predict, with minimal lag time, when emergency-room traffic is about to rise.



The UAV tracks the target for the helicopter, which loiters out of visual range.

1



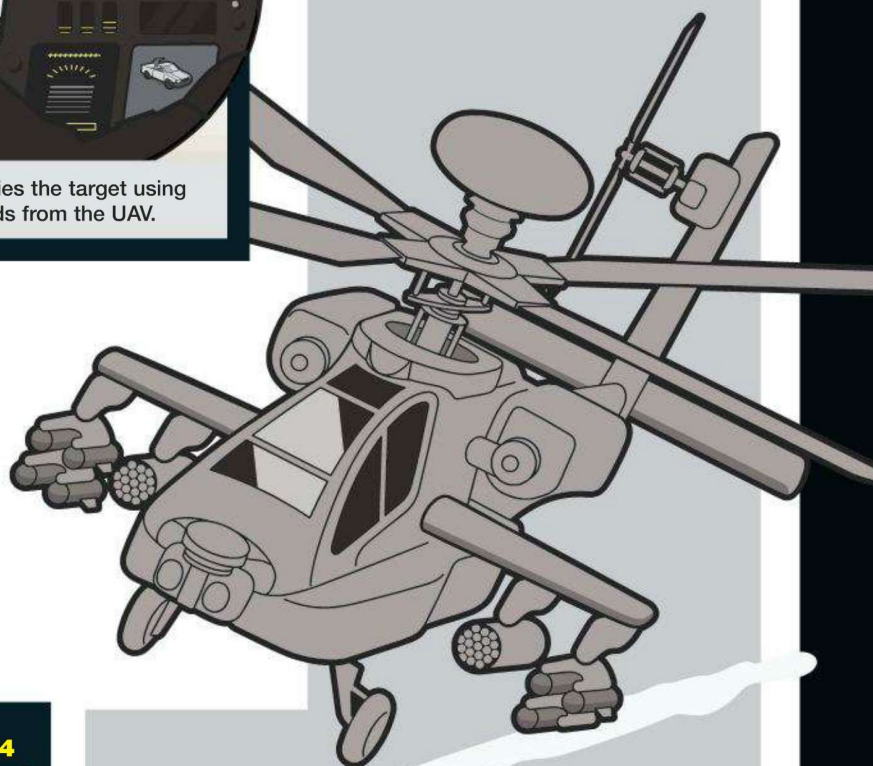
2

The pilot verifies the target using live video feeds from the UAV.



3

The UAV beams ballistic information – temperature, wind and the target's range and speed – to the Apache's fire-control computer.



21ST CENTURY WARFARE

Apache eyes

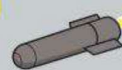
ATTACK-HELO PILOTS GAIN DIRECT CONTROL OF UAVS. *BY JOE PAPPALARDO*

Human-robot teamwork has reached a deadly new level. Upgrades to the AH-64D Apache Longbow helicopter have enabled its airborne pilots to control unmanned aerial vehicles and use the UAVs' video and targeting data to launch a missile attack. Combat deployment could come in 2013.



4

The attack-helicopter pilot, still safely out of sight, shoots the target.



Other upgrades

NEW GEAR IS ALLOWING APACHES TO FLY, FIGHT AND LAND MORE SAFELY.

ENGINE

General Electric's 701Ds offer a 5 per cent power boost and more durability while running hot.

ROTORS

Composite rotor blades help increase the Apache's speed, climb rate and payload.

TRANSMISSION

The 2 540-kW drive system, with a split-torque face-gear transmission, provides more power than current Apaches.

LANDING GEAR

Enhanced hydraulic struts adjust to the weight load of the aircraft and help control deceleration during a touchdown.

BRAIN SCIENCE

Seeing addiction

Neuroscientists are peering into the brain to understand the biological impact of addiction. Using functional magnetic resonance imaging (fMRI) of the cerebral blood flow, UCLA researchers have been able to pinpoint when smokers experience nicotine cravings. Subjects watch videos while being scanned with fMRI; by measuring which areas of the brain become active, the team can tell with 90 per cent accuracy if the subjects are watching a video that shows people smoking. Researchers are also studying more modern addictions.

Investigators in China compared the brains of 17 teens diagnosed with Internet addiction disorder (IAD) with those of a group of unaddicted peers. In the IAD group, they found significant abnormalities in the white matter connecting brain regions involving emotions, attention and decision-making – strikingly similar to the brain profiles of drug addicts. Such scans could ultimately help refine techniques to fight cravings, as well as identify IAD and monitor the progress of treatments.

– ALEX HUTCHINSON



PM SCORECARD

Oil spill anniversary

TWO YEARS AGO THIS MONTH, BP'S DEEPWATER HORIZON DRILLING RIG EXPLODED, KILLING 11 AND DUMPING 5 MILLION BARRELS OF CRUDE INTO THE GULF OF MEXICO. OFFICIALS VOWED IT WOULDN'T HAPPEN AGAIN, BUT HAVE THINGS CHANGED? – ALYSON SHEPPARD

RHETORIC

TIGHTEN GOVERNMENT OVERSIGHT

In May 2010, the US Minerals Management Service (MMS) was charged with egregious ethics violations, such as accepting gifts from the oil industry. The country's secretary of the interior pledged to root out "bad apples".

ASSESS THE DAMAGE

During the crisis, White House adviser David Axelrod said, "Obviously we're dealing with the greatest environmental catastrophe of all time." Some pundits predicted the Gulf would become a wasteland.

REFORM OFFSHORE RULES

The National Oil Spill Commission's report released in January 2011 called for "fundamental reform" to DOI regulations governing deepwater oil and gas exploration, production and spill response.

REALITY

To reduce conflicts of interest, the MMS was split into three separate organisations to oversee planning, inspecting and revenue collecting. The Department of the Interior (DOI) set up an internal investigation and review unit to police its agencies.

Although the offshore spill was the largest in US history, it was not as catastrophic as predicted. Favourable currents and topography prevented the oil from spreading and allowed bacteria to break it down quickly. A government study projects a reduction in bluefin populations of less than 4 per cent.

Marilyn Heiman of the Pew Environment Group says the DOI has improved safety and containment requirements for drillers but has not altered its spill-response and -preparedness rules. Most new government requirements expire in three years.



> Visit www.popularmechanics.co.za for more information on the BP oil spill, including how the blowout happened, the aftermath, an interview with Captain Roger Laferriere, who was responsible for surface operations, and more (search keyword: Deepwater Horizon).



QUICK HITS



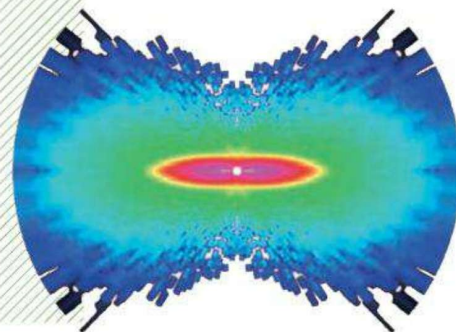
Mapping a cosmic unknown → Dark matter makes up about a quarter of the matter in the universe and scientists still don't know exactly what it is – but at least now they know where it is. An international team spent five years observing 10 million galaxies using a 340-megapixel camera mounted on a telescope in Hawaii. By studying how the light from these galaxies was deflected along its route to Earth by the gravitational force exerted by clumps of invisible dark matter, the researchers were able to piece together a map of dark matter's distribution spanning more than a billion light-years. It is the first glimpse of dark matter on such a large scale.

BREAKTHROUGH

GOOD VIBES

Using a new ultra-fast camera, researchers have recorded the first real-time image of two atoms vibrating in a molecule. Key to the experiment, revealed in a recent issue of *Nature*, is the researchers' use of the energy of a molecule's own electron as a kind of "flashbulb" to illuminate the molecular motion. The team used ultra-fast laser pulses to knock one electron out of its natural orbit in a molecule. The electron then fell back toward the molecule scattered off of it, analogous to the way a flash of light scatters around an object, or a water ripple scatters in a pond.

Principal investigator Louis DiMauro of Ohio State University said the feat marked a first step towards not only observing chemical reactions, but also controlling them on an atomic scale. "The next step will be to see if we can steer the electron in just the right way to actually control a chemical reaction."





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KID ROBOTICS

Engineering + Science = Invention

There is the kind of problem kids solve in maths class. And then there is the kind of problem they solve after maths class. For the nearly 300 000 students involved in FIRST programmes, founded by master inventor Dean Kamen, the latter isn't homework – it's a way of life. Each year the students spend countless hours building a path to robotic glory that culminates in a world championship in April. But given enough hardware, mentoring and ambitious challenges, it was only a matter of time before these engineers in training began patenting inventions of their own. – JENNIFER BOGO



Office White House Photo by Pete Souza

SMARTwheel The Inventioneers from New Hampshire had already filed three provisional patent applications by the time they created the SMARTwheel in response to a FIRST Lego League Challenge. "We found out car crashes were the No 1 cause of death for teens and texting was the main distraction," says 11-year-old Bryeton Evarts. "We wanted to do something to stop that." Their solution is a steering wheel cover that detects when a driver removes a hand for more than 3 seconds and emits visual and audio alerts. A data logger communicates unsafe driving behaviour in real time. Writing the utility patent application was 16-year-old Tristan Evarts's favourite part: "You can conceptualise your idea, but until you have to list all its features on paper, you don't fully understand what it is."



Picture by Roccobotics

PDBot The US high school students on the Pink Team made bots only for the FIRST Robotics Competition – until their local police department asked if they had one to spare. In response, the students built a robot to spec. It can climb rugged terrain, deliver a negotiation phone, launch smoke grenades and conduct surveillance. "We were searching other police robots and were shocked by how much they cost for what they could do," says Jason Schuler, a contract engineer for Nasa, a team mentor and a FIRST alum. So the team filed a provisional patent for its PDBot and optimised the design for a kit that other teams can use to fundraise. "Instead of washing cars to raise money, they'll be building robots," Schuler says.

Folding Forklift Last year, the Purple Gears had to build a robot that could lift batons from the top of a 56-cm dispenser for the FIRST Tech Challenge. The problem: their robot couldn't be more than 450 mm high. "We couldn't use hydraulics – that was another restriction," says senior Ariana Keeling. So the high school students decided to construct a forklift that unfolds, then learned one had never been invented. On the utility patent application, they listed each team member's contributions to the design. That taught them something else valuable, says mentor John Toebes, director of patents at Cisco: "Invention is not a solo act." This year, the Purple Gears are filing for a second utility patent for a brand-new kind of wheel.

PM



To find out more about the FIRST Lego League, visit www.fllsa.org



Taking up the design challenge

The growing consensus of the need for greener, more resource efficient ways of living makes this an era of exploration.

Energy efficiency and eco-friendliness are among the main considerations of forward-thinking consumers. They've become top of mind when building, decorating and revamping homes. It's up to us, the people with the know-how, to create solutions that enable them to achieve their green aspirations.

On the lighting front, we've got a head start. Innovation and advancements in energy efficient, long-lasting lighting technologies have ensured that there is now a low energy alternative for almost every lighting application.

There is still a lot of terrain to be charted as we merge good design with the energy efficient alternatives available to us. We've been given the reins: we just have to take them.

A smart mix of efficient lighting technologies and a clever approach to lighting design, installation and layout are necessary for practical, aesthetic and efficiency requirements to be in sync. Herein lies the opportunity to create, innovate and satisfy.

Take it further

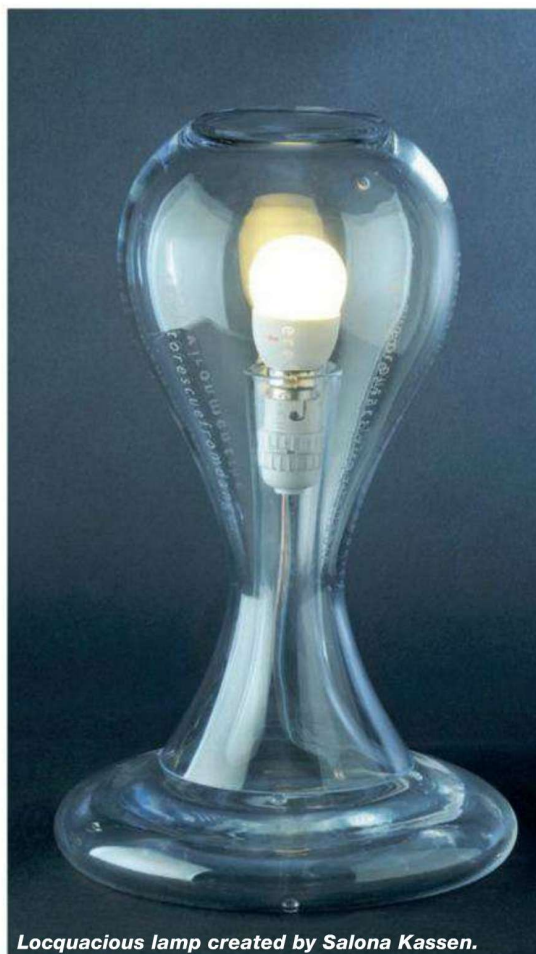
Have you explored the terrain of energy efficient lighting? Do you have an idea for an energy efficient lighting technology, lamp, system or product?

Eskom is inviting designers, innovators, engineers and students to submit their energy efficient lighting innovations to the **Eskom Energy Efficient Lighting Design Competition 2012**.

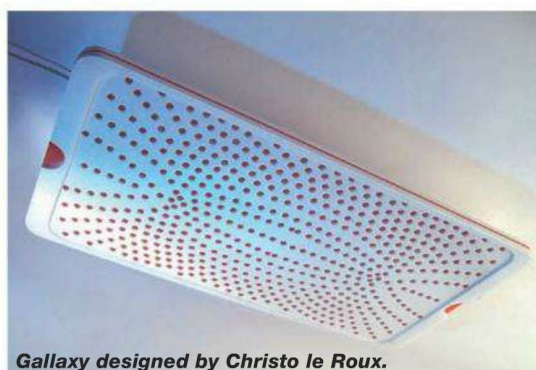
The goal of the competition is to show that efficient lighting technologies can be used – and mixed and matched – in contemporary lighting designs and systems for homes.

Since 1999, the biennial competition has helped mobilise transformation in the market, motivating lighting designers, architects and interior designers to use energy efficient lighting in their portfolios, and inspiring consumers to adopt innovative and green lighting concepts.

Participating and being honoured in the Eskom Energy Efficient Lighting Design programme is an accolade that entrants can leverage as a launch pad into energy efficient design and development in South Africa's increasingly eco-conscious residential sector.



Locquacious lamp created by Salona Kassen.



Galaxy designed by Christo le Roux.



Lesedi Molosiwa's Canalot lamp.

Entrants can win their share of R214 000 and the chance to walk away with the prestigious Sparks Trophy. The deadline for entries is midnight on 31 August 2012. Full details are available at www.lighting-design.co.za or from Ruth Kolevsohn at ruth@silverroot.co.za

The competition is supported by Philips, the Radiant Group, LED Lighting SA, Voltex, Eurolux, ARB Electrical, OSRAM, the Department of Energy, the *eta* Awards, 49M, NEEA, NMISA, SESSA, IESSA, Technology Innovation Agency, the South African Institute of the Interior Design Professionals, *Miss Earth*, *Electricity and Control*, *Sparks Electrical News*, *Vector*, *Lighting in Design* and *VISI* magazine.

WEIGHT: 544 310 KG • FIRST FLIGHT: 2015 • FIRST PAID FLIGHT: 2020

STRATOLAUNCH

The world's biggest aircraft will have a simple job: take a two-stage rocket to 9 000 metres, drop it, and get the hell out of the way as it blasts into orbit.



• STRATOLAUNCH
WINGSPAN: 117 M
LENGTH: 65,5 M



• HUGHES H-4 HERCULES
(SPRUCE GOOSE)
WINGSPAN: 97,5 M
LENGTH: 66,7 M



• AIRBUS A380
WINGSPAN: 79,5 M
LENGTH: 73,1 M



• SPACE SHUTTLE
WINGSPAN: 23,8 M
LENGTH: 56 M

MERLIN
ENGINES,
556 000
NEWTONS OF
THRUST EACH
AT SEA LEVEL

TWO-STAGE
ROCKET,
36,5 M
LONG

6 100 KG
OF CARGO
TO LOW-
EARTH
ORBIT

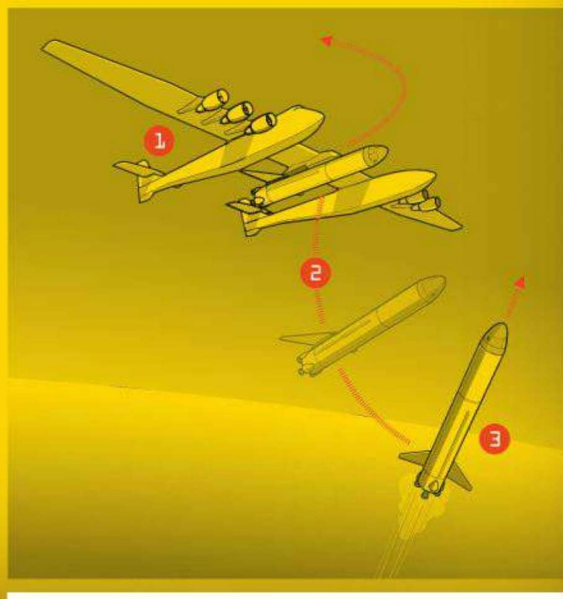


SIX PW4056
TURBOFAN
ENGINES
FROM TWO
BOEING
747-400S

1) MOTHER
SHIP FLIES
TO LAUNCH
POINT AT
9 000 M.

2) ROCKET
BOOSTER'S
FINS ORIENT
ROCKET
VERTICALLY
AS IT
DROPS.

3) ROCKET
ENGINES
IGNITE,
SENDING
PAYLOAD
TO ORBIT.



BY MICHAEL BELFIORE

STUART WITT guns the motor of the white SUV known as Mojave One and drives it up a dun-coloured mound of earth. From atop his wind-swept perch, the CEO of the Mojave Air and Space Port surveys a fleet of graders and other heavy equipment churning up 7,7 ha of dirt beneath a blue desert sky.

At the moment, it's just a sprawling construction site, but within two years, work will be completed on a pair of hulking buildings. One will be a fabrication facility for the world's biggest aircraft. The other will be the hangar that houses it. "You're looking at something that's going to

ILLUSTRATION BY VLADIMIR SHELEST

Air-to-space dream team

be fundamentally breathtaking," Witt says.

The official name of the mammoth aircraft is Model 351, but it already has a nickname: the Roc, after the mythological bird big enough to carry away elephants for dinner.

The record-breaking plane, which will have six engines and twin fuselages, is being built to carry a rocket to 9 000 metres. From there, the rocket will drop from the plane and blast into space. The first payloads will consist of satellites and other cargo, but the programme's backers say the rocket will eventually carry passengers. The Roc will be a flying launchpad – government and private-sector customers welcome.

Incredibly, the project has been in development for more than eight years under total secrecy. Then, this past December, billionaire Paul Allen announced his Stratolaunch project to the world at a press conference in Seattle.

When the space shuttle fleet was retired in 2011, the United States lost its only way to get astronauts off the planet. Stratolaunch is the latest private-sector initiative to try to fill that void. "For the first time since John Glenn, America cannot fly its own astronauts into space," Allen said in Seattle. "Stratolaunch will build an air-launch system to give us orbital access to space with greater safety, flexibility and cost effectiveness, both for cargo and manned missions."

In the process, the Stratolaunch team hopes to build a new American space-flight industry. But there are more than government contracts at stake: when the cost of launches decreases, more industry satellites, tourists and science projects will reach orbit. Space will truly be open to the public.

To reach that lofty goal, Allen has assembled a team of mavericks from the private space industry to make Model 351 into flight-ready hardware. Scaled Composites, a Mojave-based firm founded by designer (and *POPULAR MECHANICS* Breakthrough Award winner) Burt Rutan, will make the aircraft. Says Rutan, who sits on the Stratolaunch board of directors: "To allow public access to orbit, we need to increase safety by a factor of one hundred. I think airborne launch will be a significant part of the safety solution."

The rocket will also be made to order.

There are plenty of ambitious private space companies, but the reputations of the three partners behind Stratolaunch Systems raise expectations sky-high. Each has made a career by defying the status quo.



THE AIRCRAFT:

Burt Rutan, founder, Scaled Composites

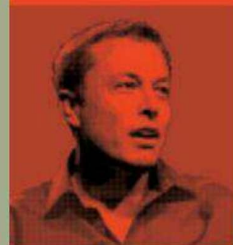
This forceful, iconoclastic and brilliant engineer is best known for designing SpaceShipOne, the first privately built craft to carry people into space. Rutan, now retired, sits on Stratolaunch's board of directors; Scaled is building the aircraft.



THE ROCKET:

Elon Musk, co-founder of PayPal, Tesla Motors, and Space Exploration Technologies (SpaceX)

Musk's rocketeers are trying to make SpaceX the first private company to resupply the International Space Station – and create a launcher that costs one-quarter the price of comparable rockets.



'WHY BUILD A NEW AIRPLANE TO FERRY ROCKETS? "SPECIALISED AIRCRAFT FOR SPACE LAUNCH ARE OPTIMISED FOR THEIR PAYLOADS," BURT RUTAN SAYS. "JOINING TWO 747S WOULD NOT GET YOU AN AIRPLANE CAPABLE OF LAUNCHING THE STRATOLAUNCH BOOSTER.'

For that, Allen approached PayPal co-creator Elon Musk, who founded Space Exploration Technologies (SpaceX). Building a two-stage rocket that will be dropped from an aircraft is the kind of bold challenge that SpaceX was created to tackle, but hitting the specifications for mass, centre of gravity and other technical details will be tricky. "We're in what I call the rocket-design box," says Gwynne Shotwell, SpaceX's president, "where we can be only so long and weigh only so much but still need to get a specific amount of payload to orbit. Piece of cake."

FLIGHT OF THE ROC

In 2015, hangar doors wider than the length of a football field will slide open. The 544-ton Stratolaunch mother ship will lumber directly on to Mojave's Runway 30, which extends 3 800 m through the desert scrub toward the windmills churning the air in the foothills of the Tehachapi Mountains. The Roc's gleaming white, 117 m wings will cast long, slender shadows as the plane moves into the bright California sun.

When air traffic controllers clear the Roc for take-off, its crew will throttle up six Pratt & Whitney 4056 turbofan jet engines, each of which generates about 293 000 newtons of thrust. The high-pitched turbine whine of a four-engine 747 reaches 140 decibels during take-off. That's 20 decibels above the pain threshold – and the Stratolaunch vehicle will have two additional engines.

The shriek of the Roc on take-off will echo a long distance – which is one good reason to base its development in the empty desert at Mojave. Accelerating down the runway



THE MONEY:

Paul Allen, co-founder, Microsoft

This billionaire was the sole funder of Rutan's SpaceShipOne project. Stratolaunch, which will be the first wholly privately funded space transport system, is his second space venture. "It will keep America at the forefront of space exploration," he says.



THE AIRFIELD:

Stuart Witt, CEO, Mojave Air and Space Port

Witt has been privy to the Stratolaunch plan for years, and prepared his facility for its commencement. He extended runways and oriented the Stratolaunch's hangar doors so they will open directly on to a runway he extended in 2007.

will put some flexion into the wings, probably giving them a bit of a flapping quality as the plane takes off.

Mojave will host test flights. Paid space launches, scheduled to begin in 2020, will depart from

Cape Canaveral, Florida. There, the aircraft will carry a 36 m rocket mounted to the bottom of the spar connecting the fuselages. The sight will be dramatic – an aircraft with a wingspan greater than the length of a football field, carrying a rocket with wisps of vapour escaping from its cryogenic liquid oxygen tanks.

Allen envisions the system one day delivering as many as six people per flight into space. The passengers will buckle into seats inside a capsule at the rocket's tip. Assuming the capsule has windows, these paying customers will be treated to views of the receding Florida coastline and, after a steady climb, the curvature of Earth.

And then it gets exciting. Once at 9 000 m, the Roc's crew will start a brief count-down and flip the sequence of switches that releases the rocket. The pilots will then veer away sharply to stay clear of the rocket's flight path.

During the drop, fins will pitch the rocket at a steep angle for its impending climb to space. The capsule passengers' orientation will shift: imagine tipping over your chair, and that brief but gut-wrenching free-fall. And then imagine being slammed back

into your seat by g-forces as the rocket's engines ignite, exerting over 2,2 million newtons of thrust.

Once in space, 90 000 m above the release point, the rocket will drop the first stage, and the second will fire, flinging the capsule (or 6 100 kg of payload) the rest of the way into orbit. By then, the passengers will be floating in their harnesses.

BLAST-OFFS FROM ALTITUDE

Launching spacecraft from aircraft is an idea that is as old as spaceflight. In the



Picture by Dan Chavkin

early 1960s, pilots – including future Apollo 11 astronaut Neil Armstrong – began shooting for the edge of space in X-15 rocket planes dropped from B-52 bombers. In the late 1990s, the Pentagon began investing in air-launch ventures to develop the capability of deploying a spy satellite over an unexpected hotspot or replacing a disabled sat.

Private space companies have launched small rockets from converted civilian airliners and the cargo bays of military transport aircraft (see “Why air launch?” elsewhere in this article). But the concept has never before been tried on the scale of the Roc.

Rutan and Allen’s earlier space collaboration now seems like a test run for Stratolaunch, both in terms of strategy and design. In 2004, a mother ship called WhiteKnight carried a manned spacecraft, SpaceShipOne, to launch altitude. From there,

SpaceShipOne reached 99 900 m and then landed under its own power. When Scaled was able to repeat the feat within 14 days, the company won the \$10 million Ansari X Prize. Like the Roc, WhiteKnight carried its payload between twin spars, but the Stratolaunch aircraft’s cockpit is nested at the tip of one spar.

Allen won’t confirm Stratolaunch’s price tag, but he says it “is going to end up costing at least an order of magnitude more than what I put into SpaceShipOne (\$28 million)”. Allen and company believe that the hundreds of millions of dollars and the design challenges of the project will be offset by an “any orbit, any time” capability.

When launching a spacecraft to a target in orbit – say, a space hotel – a launch provider can either wait until the facility is overhead, or launch, enter orbit and spend days chasing the destination. But

the Roc will be able to take off from any runway long enough to accommodate it, fly 2 400 km, and launch a rocket when the orbital facility is overhead.

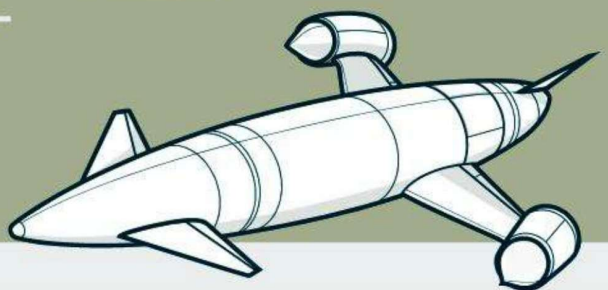
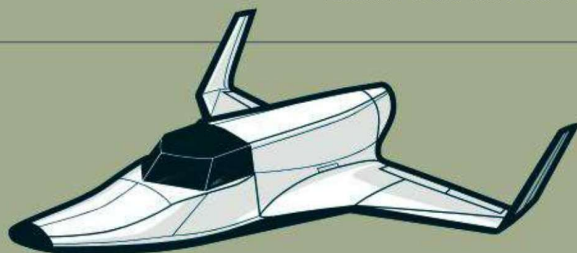
The Stratolaunch team isn’t speculating as to who or what will eventually hire the system to fly to space. “Paul has tasked us with getting the design moving forward,” says Stratolaunch president and former Nasa chief engineer Gary Wentz. “Right now, we’re not pursuing customers.”

SCAVENGED HISTORY

In early February, a pair of United Airlines 747s from Victorville, California, landed

Private space planes

The huge plane in the Stratolaunch system is used to hoist a rocket to high altitude, release it, then veer away as the rocket launches into space. But the mother ship itself is not a space plane. That designation is reserved for aircraft that can reach space under their own power, manoeuvre there, return to Earth, and land. Private space companies are busy designing these reusable craft. Here are three new models.



LYNX / 9 m long

This suborbital-only space plane from XCOR, based at California’s Mojave Air and Space Port, is designed to fly micro-gravity research payloads, as well as tourists, just past the edge of space. Taxi tests are scheduled for late 2012; a short first flight could come by year’s end.



DREAM CHASER / 9 m long

This seven-passenger space plane, developed by Sierra Nevada Corporation, will launch from Cape Canaveral atop an Atlas V rocket, enter orbit, return to the atmosphere, and land on a conventional runway. Nasa-funded testing means first flights as early as mid-year. Sierra Nevada says regular flights will start in 2016.



SKYLON / 82 m long

This single-stage unpowered craft, made by England’s Reaction Engines, will blast directly into space from a runway without a boost from an airplane or rocket, carrying cargo or a passenger compartment. Engine tests began last year; company engineers expect flights within a decade.

This Pratt & Whitney 4056 engine, shown here on a former United Airlines 747-400 that landed at Mojave Air and Space Port in early February, is one of six to be used on the Stratolaunch mother ship. Engineers will cannibalise the jet's landing gears, too.

Picture by Dan Chaykin



VIDEO > Visit www.popularmechanics.co.za to watch a video revealing more about the Stratolaunch project.

at Mojave. They won't leave intact. The two aircraft will be cut to pieces and their parts repurposed for the Stratolaunch prototype, including the six engines that will be mounted on the Roc's wings. Engineers will also cannibalise the airliners' landing gear.

The Roc's airframe will be new, built of carbon fibre. Aerospace engineers are finalising that design in Scaled's engineering offices in Hangar 78 at Mojave. Says Kevin Mickey, Scaled's executive vice-president: "We've grown up with airplanes that are of a scale where you call 10 of your buddies over and say, 'I'm going to put this wing on today'. Building an airplane of this size is more of a shipyard-type logistic challenge." So cranes and big jigs will be the order of the day.

The Roc is not regarded as pretty, even by its creators. "We're all aircraft guys; we love swoopy shapes," Scaled programme manager Joseph Ruddy says. "But that's not this thing's job. This thing's job is to carry this rocket and drop it."

Engineer and test pilot Doug Shane, Rutan's successor as head of Scaled, says

the team will fabricate as many identical carbon fibre-skin sections as possible. "If you look at our products, it's very unusual to have any common geometry to any adjacent part of the vehicle," Shane says. With flat sides on the fuselage, Scaled can make panels and clone the part for use almost anywhere on the aircraft.

Given Rutan's penchant for aviation firsts – aircraft based on his designs have set multiple round-the-world records – one might suspect he joined the Stratolaunch project partly because it gives him a shot at one last career-capping superlative. But Rutan strongly disagrees with that view. "It would be nice to not have to build the world's largest airplane to do the Stratolaunch mission."

FOR-HIRE ROCKETEERS

No one at Mojave is currently building rockets at the Stratolaunch scale, so Allen turned to Elon Musk. His SpaceX skunkworks is brazenly rewriting the rules of spaceflight by creating and launching rockets quickly and cheaply.

The company has already flown the Falcon 9 rocket, named for its nine main engines, and the Dragon space capsule into orbit. The company is now preparing for cargo flights to the International Space Station. Musk says manned flights could commence as early as 2014.

The Stratolaunch rocket will have the same diameter as the Falcon 9 (3,65 m), but engineers will trim its length by about 18 metres. "We call it the Falcon 9 Shorty," SpaceX president Shotwell says. Engineers will stunt the rocket by taking out some of the barrel sections that they weld together to make up a typical Falcon 9.

Many elements of the design are not yet finalised. Even the number of rocket engines has not been settled: Shotwell wants to stick with nine engines; Wentz wants fewer. "Nine engines are not required for the performance or control of this rocket," he says. "Including them would add cost and mass."

They have to come to an agreement quickly, as the project is on a tight schedule.

Why air launch?

Launching spacecraft from aircraft is not a new concept – and it has advantages over a ground launch. An air-launched rocket is lighter because it needs less fuel to reach orbit and doesn't require shielding to protect it from the engines' acoustic energy, which reflects off the ground.

← **1963: Nasa pilot** Joseph Walker reaches space three times in an X-15 rocket plane dropped from a B-52. He is the first person to get to space more than once.

1990: Orbital Sciences becomes the first private space launch company when it drops a Pegasus rocket from a B-52. The system, using a Lockheed L-1011, is still in operation.

2004: Scaled Composites' WhiteKnight takes off from California's Mojave Air and Space Port and launches SpaceShipOne from its position beneath the plane's central fuselage. A larger version, WhiteKnightTwo, is undergoing flight tests.



Wentz's timetable calls for Roc flight tests to start in 2015; flights with an actual rocket won't begin until 2020 in Florida.

Scaled must lure engineering and design talent to Mojave to staff up Stratolaunch. "The biggest challenge is finding the people who have the right mindset to do this kind of work, who want to take responsibility for the parts they do (create)," Ruddy

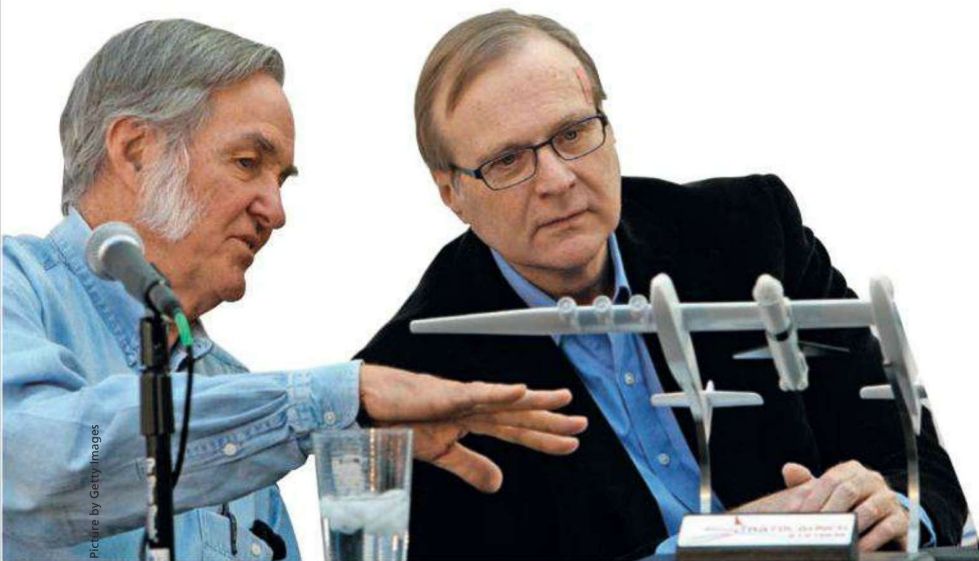
says. "We have to adjust them to our culture. A lot of aerospace is geared to production-type mentality. The prototype world is a little different."

Stratolaunch suits Witt's vision of Mojave as the centre of this prototype world, where cutting-edge aerospace companies have the room to innovate. "What brought the Wright brothers to Kitty Hawk was freedom from encroachment of the press, freedom from industrial espionage, and a steady breeze," Witt says. "The fact that we were able to keep this under wraps for nearly nine years says that we still enjoy the elements that took Orville and Wilbur to Kitty Hawk."

No one will mistake the 544 310 kg Roc for the 274 kg 1903 Wright Flyer. But if this astounding piece of engineering takes to the sky, engines screaming and rocket blazing, the aerospace pantheon will welcome a new aircraft – a very big one.

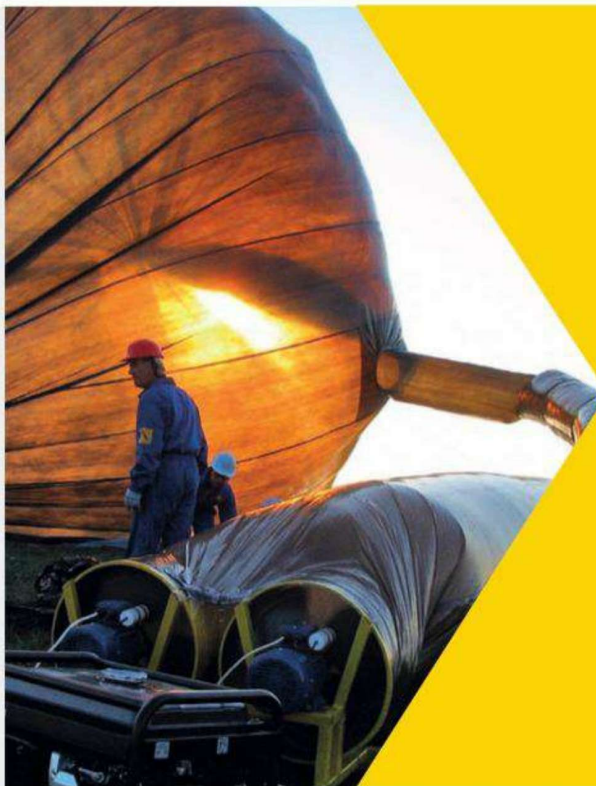
PM

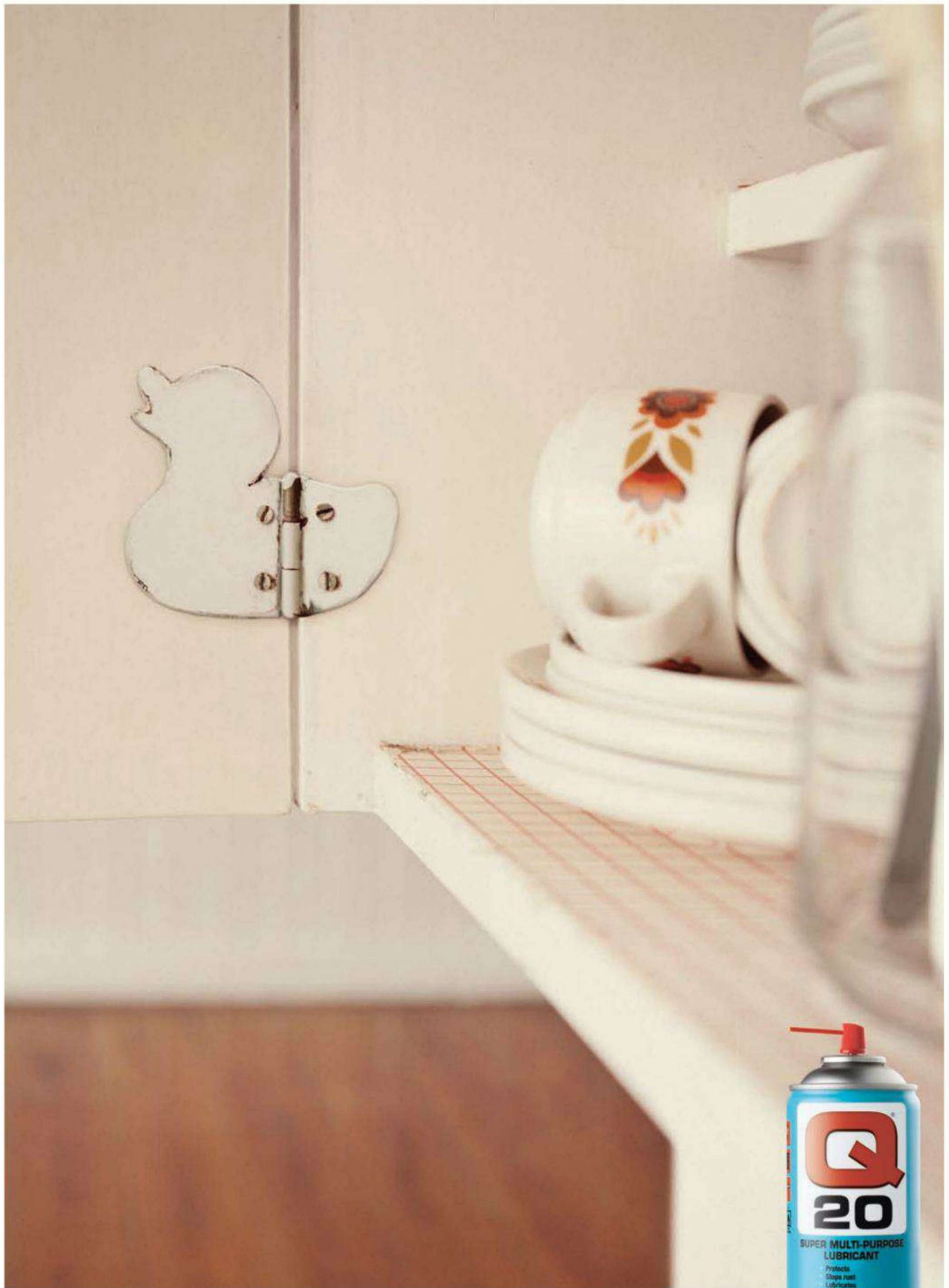
Rutan (left) and Allen – with a model of what will be the world's biggest aircraft – announced the Stratolaunch project at a press conference in Seattle in December 2011.

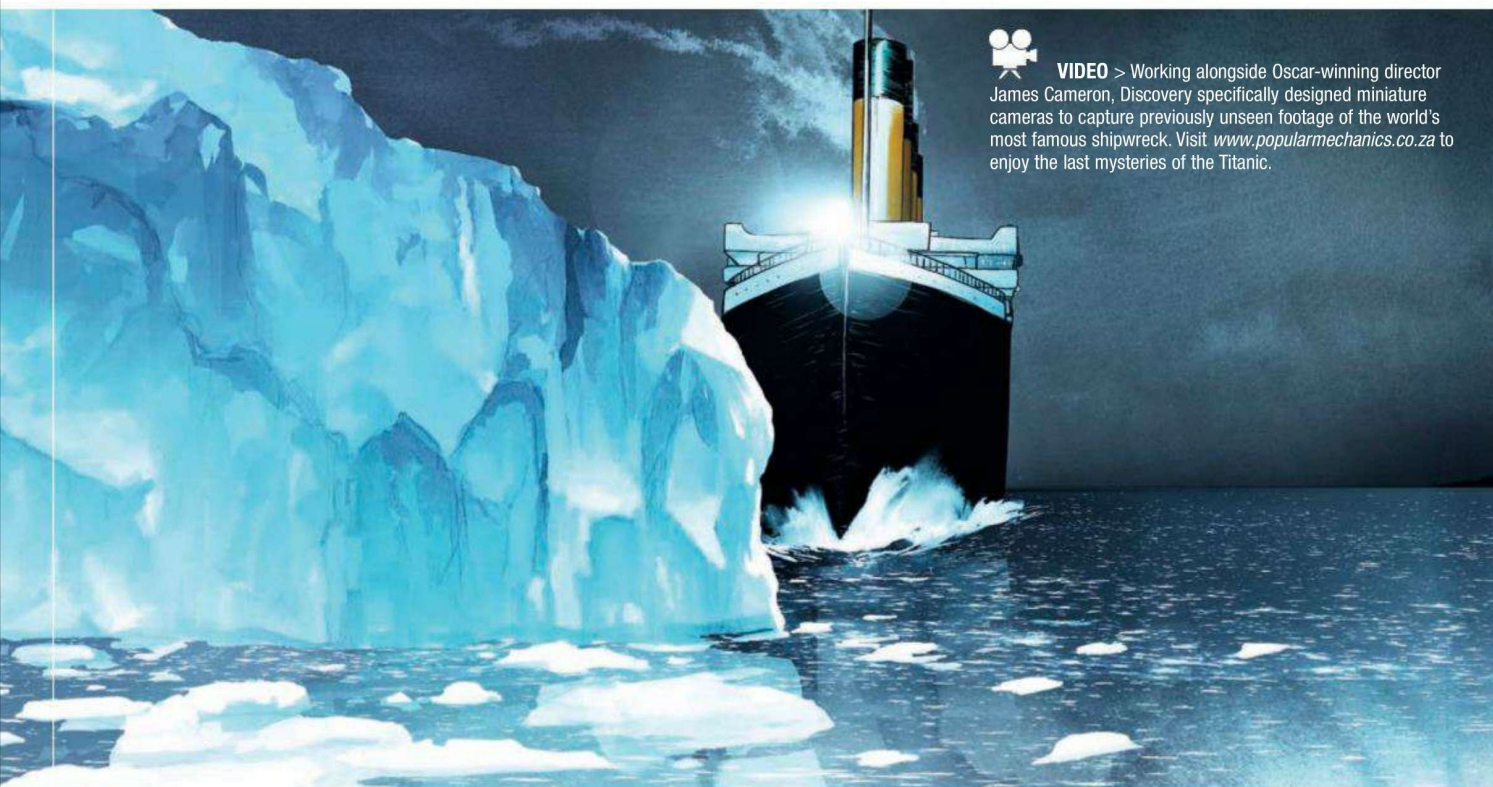


2006: AirLaunch, a Seattle-area company working under a Pentagon contract, drops a space rocket from the back door of a C-17, setting a record for the heaviest single object dropped from the military cargo plane – 29 000 kilograms. In 2008, when the contract ends, the company folds. ↑

2010: Google Lunar X Prize competitor ARCA, based in Romania, announces plans to launch a three-stage space rocket from a balloon. In October 2010, ARCA fires a prototype rocket from a balloon at 13 700 metres. →







VIDEO > Working alongside Oscar-winning director James Cameron, Discovery specifically designed miniature cameras to capture previously unseen footage of the world's most famous shipwreck. Visit www.popularmechanics.co.za to enjoy the last mysteries of the Titanic.

WHY TITANIC STILL MATTERS

AN ICEBERG DIDN'T SINK *TITANIC* – HUMAN ERRORS DID. FROM THE BP OIL SPILL TO 2012'S *COSTA CONCORDIA* SHIPWRECK, *TITANIC*'S LESSONS STILL APPLY.

> BY JIM MEIGS > ILLUSTRATION BY OWEN FREEMAN

WHEN THE RMS TITANIC went to the bottom of the Atlantic in the early hours of 15 April 1912, it carried with it the era's uncritical faith in the promise of technology. The ship was the jewel of the industrial age. That such an extravagantly engineered behemoth could fall victim to the everyday risks of sailing the North Atlantic was more than shocking; it set off a period of deep scepticism about the relationship between man and his machines.

A series of inquests and reports laid out the reasons for the catastrophe and led to reforms in marine engineering and maritime law. But one risk factor couldn't be eliminated: human fallibility. In an article published in *POPULAR MECHANICS* soon after the tragic event, we noted that the Titanic "simply furnished another example of the

well-established principle that if, in the conduct of any enterprise, an error of human judgment or faulty working of the human senses involves disaster, sooner or later the disaster comes."

In one respect, little has changed. As the recent loss of the Italian cruise ship *Costa Concordia* demonstrates, bad decision-making can overcome even robust engineering. Virtually all man-made disasters – including the Three Mile Island nuclear accident, the space shuttle *Challenger* explosion, and the BP oil spill – can be traced to the same human failings that doomed *Titanic*. After 100 years, we must still remember – and, too often, relearn – the grim lessons of that night.

No disaster is a single event. Complex systems rarely fail without warning. Instead,

accidents are the product of decisions made over hours, days and sometimes years. Those choices are shaped both by the culture of the organisation – whether it's Nasa or the White Star Line, which owned *Titanic* – and by outside pressures.

On the morning of 28 January 1986, the launch of the *Challenger* had already been postponed six times. Ever image-conscious, Nasa brass pushed to launch, despite the objections of engineers who worried that the rubber seals between segments of the vehicle's booster rockets might fail in the unusually cold temperatures. One of those engineers, Allan J McDonald, recounts in his book *Truth, Lies and O-Rings: Inside the Space Shuttle Challenger Disaster* that small quantities of combustion gases had leaked through the seals on previous missions. It was a warning sign – but Nasa came to accept the leaks as normal. Engineers were forced into the impossible position of trying to convince officials that their worries were valid. "Is it safe to fly?" is the correct question," McDonald tells *POPULAR MECHANICS*,

The *Costa Concordia* foundered off the Italian coast on 13 January 2012. In an echo of the *Titanic* shipwreck, human errors contributed to both the accident and the subsequent loss of at least 17 lives.

"not that you have to prove it will fail."

Like the space shuttle, *Titanic* was the technological pinnacle of its day. But a series of decisions – from carrying too few lifeboats to using a rudder that may have been too small to enable the ship to turn quickly – pared its margin of error. Those risks were compounded by unsafe operation. Accounts differ on whether White Star Line managing director J Bruce Ismay urged Captain Edward Smith to speed across the Atlantic in the hope of setting a record. But there's no question that the captain sailed the new and barely tested vessel through a region of known iceberg risk at nearly full speed on a moonless night. (A nearby ship, the *SS Californian*, had stopped for the night.) It was just one more bad decision along the *Titanic's* doomed path.

Success can breed complacency. During a career of more than four decades, the *Titanic's* Captain Smith had been involved in only a single accident at sea, one that ended without loss of life. The *New York Times* noted that Smith's "rise in rank and importance was commensurate with the safe uneventfulness of his command".

Major disasters often occur after such long, uneventful stretches. Before the partial meltdown of the reactor at Three Mile Island in 1979, no US nuclear plant had experienced a serious accident for 25 years. Similarly, before the blowout of the BP Macondo Prospect well in April 2010, the Deepwater Horizon rig had gone seven years without a serious mishap while drilling some of the deepest wells on the planet. "When you think you have a robust system, you tend to relax," Henry Petroski, a professor of civil engineering at Duke University, tells *POPULAR MECHANICS*. Over time BP and its contractors began to cut corners: alarms that would have warned of a gas leak were silenced, safety checks cancelled. The blow-out preventer – a last-ditch device intended to shut off a runaway well – was only



partly functional. And workers were constantly urged to drill faster. That kind of culture invites trouble.

Technology can outpace judgment. The construction of *Titanic* came at the apex of a remarkable period of innovation in shipbuilding. Well before the launch of *Titanic*, Captain Smith expressed supreme confidence in the state of maritime engineering: "I cannot imagine any condition (that) would cause a ship to founder," he said in 1907. "Modern shipbuilding has gone beyond that."

With three powerful engines, *Titanic* could maintain high speeds day or night.

But the crew's ability to spot hazards was little changed from the days of sail. Two men stood in a crow's-nest scanning the horizon – they didn't even have binoculars. The ship was equipped with the latest communications innovation, wireless telegraph, and in the hours before the collision the ship received five warnings about icebergs from other vessels. But at the time, the telegraph was seen primarily as a luxury service for passengers, and the crew had no firm protocol for acting on the information. One message was handed to Ismay, who slipped it into his pocket, apparently unconcerned.

Similarly, at the time of the Gulf of Mexico blowout, BP and its contractors were pushing the art of undersea drilling into ever-deeper waters, using increasingly

sophisticated equipment. And yet the procedures to monitor and control these deep wells had not advanced much beyond those used in shallower seas.

Leaders may fail to plan for the worst. Just as Deepwater Horizon crews derived a false sense of confidence from their blow-out preventer, the White Star Line put undue faith in the supposedly watertight compartments that composed *Titanic's* lower decks. The compartments were not sealed at the top; if the ship's bow dipped low enough, seawater would flow from one compartment to the next like water filling an ice cube tray. The probability of that happening? Low. The consequences when it did? Catastrophic.

And so, the sinking of *Costa Concordia* feels sadly familiar. The ship was studded with technology – what it lacked was good judgment by the people in charge. The captain approached too close to a rocky shore. Then, after the collision with an undersea outcrop, the crew rushed to reassure passengers that everything was fine. Had the crew quickly mustered everyone to the lifeboats instead, there might have been no loss of life. "A tool is only as good as the person that's using it," says John Konrad, a US Coast Guard master mariner and author. "All the technology in the world can't replace a good captain." That remains as true in 2012 as it was a century ago.

PM

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RECYCLING OIL SAVES THE ENVIRONMENT

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COMPILED BY SEAN WOODS seanw@ramsaymedia.co.za

CHARGE ON THE GO

Portable power solutions are a must in this day and age of mobile gadgetry. And if it's real power on the move you need, PowerTraveller's Powermonkey Discovery could be the answer. Featuring a state-of-the-art 3 500-mAh lithium polymer battery, it can fully recharge an iPhone twice, standard mobile phones 3 or 4 times, or boost iPod and MP3 player runtime by 120 hours. It's also compatible with e-readers, satnavs, handheld game consoles, portable GPS systems and more.

The Discovery comes with a durable aluminium case measuring 114 x 13 x 46 mm (that's about two-thirds the size of the iPhone 4S) and features a 6-level battery capacity display. The kit also contains three tough, tangle-free cables: 1 x USB to mini USB, 1 x USB to macro USB and 1 x USB to Apple connector. Other tips are available on request. Price: about R700. Contact distributor Wintec Solutions on 011-467 2360 or visit www.wintecsolutions.co.za



TOUCHSCREEN FOR LITTLES

If you'd like your budding rocket scientist to get a head start on all the other kids at the crèche, then we suggest you get them Leapfrog's LeapPad Explorer. This nifty device features a 13 cm touchscreen display to provide a similar experience to that of Apple's

ubiquitous iPad. However, unlike the iPad, its rugged nature makes it ideal for younger kids who still have to learn about being careful with technology. It also comes with a range of games and other software apps (all available on game cartridges) that let kids

read interactive books, create art, participate in memory tests as well as use many more educational tools. Price: about R1 200. Contact Incredible Connection on 0860 011 700 or visit www.incredible.co.za

DIRT RIDER



Who said having fun in the bush had to involve heavy sweat or bone-jarring action? Kawasaki's new PR207 Teryx 4 can convey four adults swiftly, comfortably and, above all, safely across the roughest terrain available.

Its square-tubing construction and careful design have kept the number of gussets to a minimum, producing a chassis with high rigidity and low weight. The chassis features a wrap-around rollover protection structure with key high-tensile steel sections to add strength and save weight. There are also steel engine guards to protect the motor from damage in the rough stuff.

An electrically selectable 2WD to 4WD or 4WD with front differential lock system allows effortless changing between drive systems. Because the transmission is infinitely variable and stepless, there's no need for a switchable low range setting.

To move it along, there's a 749 cm³ liquid-cooled 90 degree four-stroke V-twin engine with maximum torque of 58 N.m at 5 250 r/min. Plus, it features ground clearance of 275 mm, a cargo bed capacity of 113 kg and a towing capacity of 590 kg. Price: about R170 000.

Contact Kawasaki on 011-566 0333 or visit www.kawasaki.co.za



**Editor's
choice**

PLUG AND DRIVE

Filling in an accurate log book for the taxman is not for the faint-hearted. If you're one of those who struggle with this annual challenge, you're sure to appreciate the GPS Log Book. Doing just what its name implies, this clever little gadget plugs into your vehicle's cigarette lighter or 12 V auxiliary socket and records every trip using a high-sensitivity GPS and intelligent logging software. Zones or geo-fences are created by marking points on a map, and any trips to and from these locations are automatically categorised and stored. Data is then periodically uploaded to a Web site via your PC. Trips can be viewed using Google Maps, categorised and annotated with comments, resulting in a quick, detailed SARS-compliant tax logbook. Price: about R850. Contact GPS Log Book on 011-467 5630 or visit www.gpslogbook.co.za





BANG! WAKE UP ↑

Battling to get out of bed now that the mornings are getting darker? What you need is the Gun Alarm Clock. Here's why: first off, it doesn't have a snooze button. Instead, you have to hit the alarm's bullseye with the infrared gun, or rip the batteries out, to shut the damn thing up. For those really

competitive wake-up calls, it features three game modes: in Quick Shot mode, you have to pull off five perfect shots within three minutes. Time mode is a battle for speed each morning to see how quickly you can wake up, react and blast the target away. Finally, Random mode changes the timing,

making for an unpredictable stand-off with waking life. Other features include a shooting distance of about three metres, a 6 cm LCD display and a red LED backlight for use at night. Price: about R300. Contact Mantality on 011-462 5482 or visit www.mantality.co.za

KNOW WHERE YOU'RE AT

Getting lost in a foreign country isn't a joke. However, with TomTom's latest navigation device, the Go Live 1005, that'll never happen. That's because it comes preloaded with 66 of TomTom's most popular world maps, including North America, Australia, New Zealand, South East Asia, Europe and Southern Africa.

On the safety side, it recommends when you should take driving breaks, provides unpaved road warnings, reminds you on which side of the road to drive when abroad and much more. Its advanced lane guidance feature clearly shows which lane to take at junctions. And, on the most difficult highway intersections, it provides realistic 3D representations of the junctions to make sure you find your way.



Changed your mind about the route? Its new alternative route viewer allows you to view different routes to your destination.

Other features include a 13 cm 16:9

ratio capacitive widescreen, hands-free phone calls via Bluetooth and spoken street names. Price: about R3 800. Visit www.tomtom.com

TYPE AWAY →

Typing on touchscreens doesn't work for everyone, especially when it comes to those fiddly, minute "keyboards" on smartphone screens. Celluon's Magic Cube laser keyboard makes life much easier. Capable of projecting a QWERTY keyboard layout on an opaque surface, it connects easily to any device compatible with Bluetooth or USB 2. That includes the latest iPhone, iPad, Windows, Android and Blackberry devices.

It works by recognising keystrokes via an invisible infrared layer combined with an optical sensor. Touching a key on the projected keyboard interrupts the infrared layer. This produces UV reflections that are recognised by the sensor in three dimensions, allowing the system to assign an exact position. It can detect up to 400 characters per minute, and its 700 mAh rechargeable battery lasts for approximately 150 minutes. Price: about R1 700. Contact distributor Syntech SA on 0861 274 244 or visit www.syntechsa.co.za



BRAAI IN STYLE →

Designed to function as a complete outdoor-kitchen-in-one, the Big Green Egg (yes, that's its real name) is claimed to be even more versatile than even your indoor oven. Modelled on the clay cooking vessels used by the Chinese 3 000 years ago, this ceramic braai is designed to withstand enormous temperatures and insulate far better than other open top or kettle braais.

Thanks to a number of really cool features – namely its airtight ceramic cooking shell, infinitely adjustable airflow and precision thermometer – you can grill, smoke, roast, slow cook or bake. It's perfect for anything from pizza to ribs, Sunday roasts to desserts.

As air is drawn through the base and out through the lid, the charcoal lights quickly and is ready for cooking in about 10 minutes. Plus, its thick ceramic walls hold heat so well that about 80 per cent of the charcoal remains intact after cooking and can be reused. It's also rust-proof, easy to clean and the grill is designed to fit inside most dishwashers. The Big Green Egg comes in mini, small and large sizes; prices run from about R4 000 to R8 000. Contact distributors Rockwood Leisure on 031-502 4043 or visit <http://biggreeneegg.co.za>



COOL TOOL MOVER ↓

Getting your well-stocked toolbox from your vehicle to exactly where you need it on site can be heavy going. Fortunately, Snap-on's All Weather Mobile Tool Chest provides a great way for you to lug all your tools around without having to put your back out.

Providing a convenient, secure, versatile and watertight storage solution for tools, it's designed to be pulled along easily by hand. Features include solid rubber wheels and a 55 cm wheelbase for improved stability during transportation. The fully extendable sliding drawers can accommodate foam cutouts for tool control and accountability and the chest can be opened without having to flip the box on its side. The telescopic trolley handle extends to two positions for added comfort. A four-bar latch system prevents accidental opening, yet the latches can be opened by one hand. When the case is open, its lid doubles as a seat. Price: about R8 000. Contact Snap-on on 0861 762 766 or visit www.snapon.co.za



BE PREPARED →

You don't want to be caught unprepared while mucking about in the wild. Fortunately, if you have the Bear Grylls Survival Tool Pack attached to your belt or backpack strap, that's unlikely to happen. This all-weather work-horse features a rubberised, locking carry case that houses a 12-component Gerber multi-tool, flashlight and fire starter rod. Every tool in the kit is outfitted with durable rubber handles for easy gripping, even with gloved hands. And all of the multi-tool's components – needle nose pliers, wire cutters, wood saw, scissors and serrated blade, to mention a few – automatically lock into position. Price: about R1 200. Contact Cape Union Mart on 0860 034 000 or visit www.capeunionmart.co.za

**A WATCH FOR THE WATCHERS**

There can be nothing more worrying than having an infirm relative suffering from autism, dementia or Alzheimer's, who's prone to wandering. Lok8u's Freedom locator watch – a wandering prevention and emergency alert device – was designed exclusively to address the adults' at-risk market.

As far as the wearer is concerned, it's just a digital watch.

However, its strap has a locking feature that can be removed only by using the special release tool provided. It uses both RF and GSM technology to communicate position data. While the watch is within RF range of the portable receiver, kept by the caregiver, its range is displayed on the receiver. If user and caregiver are separated (you can set the size of prox-

imity zones), it alerts the receiver and switches over to the GSM network – sending its GPS location to the caregiver via SMS and e-mail. The available secure customer portal also allows you to track your loved ones on Google maps via the Internet. Price: about R4 000 (plus a monthly service fee). Contact Lok8u SA on 021-913 8773 or visit www.lok8u-sa.co.za

PM

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IN THE JUNE ISSUE OF **Popular Mechanics** ON SALE 21 MAY 2012

HP recommends Windows® 7 Professional.



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¹Refers to diagonal measurement of display.

²All specifications represent the typical specifications provided by HP's component manufacturers; actual performance may vary either higher or lower.

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When NEED meets DESIRE

Editor's picks

BEST OF CES

More than 3 000 companies gathered in Las Vegas for the Consumer Electronics Show (see our report-back in the March issue). Over 20 000 products appeared, but only a few stood out. Here are three new machines you need to know about for 2012.

LENOVO YOGA

With both a traditional desktop mode and an all-new touchscreen interface, Windows 8 represents Microsoft's first complete re-think of the desktop operating system since 1995. The Lenovo Yoga can open up as a 13-inch folding laptop. But the screen can move backward a full 360 degrees until it rests against the bottom of the computer. Then it operates as a flat tablet computer with a capacitive touchscreen.



NOKIA LUMIA 900

The LTE-capable Lumia, with its 11 cm screen, is the halo device for Nokia and Windows Phone in the US. It shares a sleek design with the 3G Lumia 800 but has a bigger, 1 840 milliamp-hour battery. It also sports a killer camera with a wide-angle 28 mm f/2.2 lens.

MAKERBOT REPLICATOR

Larger than the original MakerBot, MakerBot Replicator allows the amateur inventor to create objects roughly the size of a loaf of bread out of common manufacturing materials such as ABA or PLA plastic. Also, unlike the company's original 3D printer, the Thing-O-Matic, the Replicator has the ability to rapidly print dual-coloured plastic prototypes.





The Tech-O-Meter

We've addressed this issue many times, and still we hear stories of PM readers who acquire absolutely essential electronic gadgets and then have to explain to their partners why their lives would be empty without them (the gadgets, that is; not the partners). New gadgets hit the market at such a fast pace that they can become a blur. Here, we take a candid look at 10 items worth focusing on, for better or worse.

> BY JOHN HERRMAN



Diagram by Julien Riviere

1 VIZIO THIN + LIGHT LAPTOP

In a sea of MacBook Air clones, these well designed laptops stand out with clean lines, a matte finish and a distinctive style. But the guts are just Ultrabook basics.

2 ROKU STICK

This USB-size device plugs into the back of newer TV sets and instantly turns them into smart TVs with no external power source required.

3 DISH NETWORK HOPPER

A DVR that can record every major network's prime-time lineup every night for eight days. The 2 000 hours of content requires 2 TB and dubious taste. (Bundled with satellite packages in the US. Do we really want this in South Africa?)

4 GOPRO WI-FI BACPAC

GoPro makes action cams for snowboard helmets or BMX handlebars. This clip adds wrist and smartphone controls.

5 OLPC XO3

A cheap tablet for the developing world from the people who made the first cheap laptop for the developing world.

6 GRIFFIN TWENTY

The elegantly designed Griffin Twenty device turns any Apple AirPort Express into a powered stereo system.

7 POWERSKIN SPAREONE

This simple, low-tech phone runs off an AA battery. Perfect for your storm shelter, first-aid kit or underground seed bunker.

8 SHARP FREESTYLE

A small TV with wireless connectivity and batteries. Watch the game while you're tending the braai.

9 GALAXY NOTE

At 13,4 cm, this Android device is a bit too small to be a tablet and far too big to be a phone. Consolation prize: a free stylus.

10 VICTORINOX USB DRIVE

It's a USB drive you can't take on a plane or into a school or maybe even to work. In a more appropriate setting – say, a forest – you might have trouble finding uses for that astounding 1 terabyte of storage.

PM



The control mechanism on Jay's 1916 Owen Magnetic hybrid was so complicated that a placard warned operators to take the vehicle to the factory for repairs.

The premier pioneering hybrid

Jay's Owen Magnetic was ahead of its time, which ultimately proved its undoing.

> BY JAY LENO

> PICTURES BY JOHN LAMM

People think hybrids are something new, but they've been around since the beginning of the car. Ferdinand Porsche built the Lohner-Porsche series hybrid car back in 1901. It used a petrol engine to spin a generator that fed electricity to in-wheel motors. In 1917, the Woods Motor Vehicle Company of Chicago offered the Woods Dual Power, a series hybrid that could motor along – at speeds of less than 25 km/h – solely on battery power.

But I think the 1916 Owen Magnetic

might be the most interesting early hybrid of them all. The Owen Magnetic's technological leap was its electromagnetic transmission. Invented by the wonderfully named Justus B Entz, an electrical engineer from New York who once worked with Thomas Edison, the electromagnetic transmission compactly housed both a 24-volt generator and an electric traction motor. The crankshaft of a 56 kW petrol engine was attached to the generator, which sent juice to the traction motor, which in turn powered the rear wheels.





There was no mechanical connection between the engine and the drivetrain.

One could argue that in 1916, hybrids made even more sense than they do today because early manual transmissions were such a bear to operate. Most cars of the era had straight-cut gears and heavy clutches. If you were a man or a woman with a bad leg, or you simply weren't able to drive, shift and double-clutch at the same time, the Owen Magnetic was the perfect vehicle, since it has no clutch or gear shifter.

To go faster, you press on the gas pedal and then move a steering-wheel-

move the lever, and the resistance provided by the motor slows the car and charges the batteries – the same kind of regenerative mode that's found in today's hybrids.

A lot of my old cars, which weigh between 1 300 and 1 800 kg, have only rear brakes. Consequently, those brakes produce a lot of heat. When you go down a long hill, you can smell 'em starting to burn up, and they quickly fade. And if an early car's brakes get wet, oh boy, you're in for a panic. But with the Owen Magnetic, you rarely have to get on the brakes unless you need to stop

why my car has less than 14 500 km on it.

I'm not sure when the car made it back to America, but it was probably in the 1970s. I found it right here in Los Angeles. Whatever you're looking for, you can find it within 80 km of LA. During World War I, and even more so during World War II, plenty of defence contractors were on the West Coast – Lockheed, Boeing, Douglas, and many more. Engineers and other technically minded people were drawn here. With the great climate, cars didn't rust and people didn't throw anything away. A lot of the interesting cars and stuff just stayed in the area.

So why did the Owen Magnetic company fail in 1922, after producing just 700 cars? The ads called it the car of a thousand speeds. But as is sometimes the case, being better isn't always enough. The car had to be competitively priced. A 1917 Ford Model T cost \$360; Cadillacs ran about two grand. An Owen Magnetic started at \$3 700 and went up from there. Another problem was the complicated relay-and-wiring shift mechanism. It's mounted under the bonnet, alongside the steering column.

I haven't opened mine up because it seems to work fine. And, quite frankly, I'm frightened to poke around in there.

A plate on it says, "If something goes wrong, do not attempt to work on this yourself. Send it back to the factory." Who would want a car that a blacksmith couldn't fix?

In that era, most people didn't care that much about new technology. It's like the full hybrids today. They're still a hard sell because they cost more than other cars in their class. You can get better mileage, but that initial cost penalty keeps many people from buying them.

With cars, simpler and cheaper parts are often better. When the Mustang was developed, Ford considered a more expensive independent rear suspension than the solid axle the car came with. As legend has it, Ford executive Lee Iacocca said, "Americans don't give a crap about that. Make it inexpensive; make it look sexy. Don't put something in it they can't see."

Companies that don't make it in the car business usually fail because they try to sell a product that's too good, or they over-engineer it and put in more than people want or need. Sadly, that's what happened with the Owen Magnetic. **PM**

Right: The lever that changes the car's speed is located on its own ring in the centre of the steering wheel.
Below: The Owen Magnetic should be awarded a prize for best logo ever.



'THE ADS CALLED IT 'THE CAR OF A THOUSAND SPEEDS'. BUT AS IS SOMETIMES THE CASE, BEING BETTER ISN'T ALWAYS ENOUGH.'

mounted lever along six speed detents (catches that lock the movement). As you accelerate, the engine speed increases, and that in turn speeds up the generator, enhancing power. Each successive lever position increases the intensity of the motor's magnetic field and torque. Compared with operating most early cars, driving the Owen Magnetic is a breeze.

The car's other advantage was its electric brake. There's a cockpit lever that turns the traction motor – the one that drives the rear wheels – into a generator. So when it's time to slow down, you

completely, like at a stop sign. If you're going 55 to 65 km/h, you engage "regen" and you coast, or freewheel. As soon as you hit 40 km/h, you feel the transmission go eeehhhhrrr! And the car slows right down to 5 km/h. Plus, you can watch gauges that show the batteries charging.

My Owen Magnetic was originally sold straight from the floor of the 1916 New York Automobile Show and shipped to the buyer's home in Norway. He must have forgotten that there weren't many roads in Norway in 1916. That's probably

ON THE EDGE

Once a year, a thoroughly compelling Web site called *Edge* invites some of the brightest people on our planet to respond to a question. This year's challenge: 'What is your favourite deep, elegant or beautiful explanation?' Here are just two of the 192 thought-provoking replies.



co-operative venture. A male and female would couple for the shared goal of reproduction of mutual offspring.

In psychology, romantic harmony was presumed to be the normal state. Major conflicts within romantic couples were and still are typically seen as signs of dysfunction. A radical reformulation embodied by sexual conflict theory changes these views. Sexual conflict occurs whenever the reproductive interests of an individual male and individual female diverge, or more precisely, when the "interests" of genes inhabiting individual male and female interactants diverge. Sexual conflict theory defines the many circumstances in which discord is predictable and entirely expected.

Consider deception on the mating market. If a man is pursuing a short-term mating strategy and the woman for whom he has sexual interest is pursuing a long-term mating strategy, conflict between these interactants is virtually inevitable. Men are known to feign long-term commitment, interest or emotional involvement for the goal of casual sex, interfering with women's long-term mating strategy. Men's have evolved sophisticated strategies of sexual exploitation.

Conversely, women sometimes present themselves as costless sexual opportunities,

and then intercalate themselves into a man's mating mind to such a profound degree that he wakes up one morning and suddenly realises that he can't live without her – one version of the "bait and switch" tactic in women's evolved arsenal.

Once coupled in a long-term romantic union, a man and a woman often still diverge in their evolutionary interests. A sexual infidelity by the woman might benefit her by securing superior genes for her progeny, an event that comes with catastrophic costs to her hapless partner, who unknowingly devotes resources to a rival's child. From a woman's perspective, a man's infidelity risks the diversion of precious resources to rival women and their children. It poses the danger of losing the man's commitment entirely.

Sexual infidelity, emotional infidelity and resource infidelity are such common sources of sexual conflict that theorists have coined distinct phrases for each. But all is not lost. As evolutionist Helena Cronin has eloquently noted, sexual conflict arises in the context of sexual co-operation. The evolutionary conditions for sexual co-operation are well-specified: when relationships are entirely monogamous; when there is zero probability of infidelity or defection; when the couple produces offspring together, the shared



Sexual conflict theory

DAVID M BUSS

Professor of psychology, University of Texas, Austin; co-author of *Why Women Have Sex*; author, *The Dangerous Passion*

A FASCINATING PARALLEL has occurred in the history of the traditionally separate disciplines of evolutionary biology and psychology. Biologists historically viewed reproduction as an inherently



'What created the Universe in such a special low-entropy way? That's a cosmological question that we are still very uncertain about.'

vehicles of their genetic cargo; and when joint resources cannot be differentially channelled, such as to one set of in-laws versus another.

These conditions are sometimes met, leading to great love and harmony between a man and a woman. The prevalence of deception, sexual coercion, stalking, intimate partner violence, murder, and the many forms of infidelity reveal that conflict between the sexes is ubiquitous. Sexual conflict theory, a logical consequence of modern evolutionary genetics, provides the most beautiful theoretical explanation for these darker sides of human sexual interaction.



Boltzmann's explanation of the second law of thermodynamics

LEONARD SUSSKIND

Felix Bloch Professor in Theoretical Physics, Stanford; author, *The Cosmic Landscape*

THE GUIDING STAR FOR ME, as a physicist, has always been Boltzmann's explanation of the second law of thermodynamics – the law that says entropy never decreases. To the physicists of the late 19th century, this was a very serious paradox. Nature is

full of irreversible phenomena; things that easily happen but could not possibly happen in reverse order.

However, the fundamental laws of physics are completely reversible: any solution of Newton's equations can be run backwards, and it is still a solution. So if entropy can increase, the laws of physics say it must be able to decrease. But experience says otherwise. For example, if you watch a movie of a nuclear explosion in reverse, you know very well that it's fake. As a rule, things go one way and not the other. Entropy increases.

What Boltzmann realised is that the second law – entropy never decreases – is not a law in the same sense as Newton's law of gravity, or Faraday's law of induction. It's a probabilistic law that has the same status as the following obvious claim; if you flip a coin a million times, you will not get a million heads. It simply won't happen. But is it possible? Yes, it is; it violates no law of physics. Is it likely? Not at all.

Boltzmann's formulation of the second law was very similar. Instead of saying entropy does not decrease, he said entropy probably doesn't decrease. But if you wait around long enough in a closed environment, you will eventually see entropy decrease: by accident, particles and dust will come together and form a perfectly assembled bomb. How long? According to Boltzmann's principles, the answer is the exponential of the entropy created when the bomb explodes. That is a very long time, a lot longer than the time to flip a million heads in a row.

I'll give you a simple example to see how it is possible for things to be more probable one way than the other, despite both being possible. Imagine a high hill that comes to a narrow point – a needle point – at the top. Now imagine a bowling ball balanced at the top of the hill. A tiny breeze comes along. The ball rolls off the hill and you catch it at the bottom. Next, run it in reverse: the ball leaves your hand, rolls up the hill, and with infinite finesse, comes to the top – and stops!

Is it possible? It is. Is it likely? It is not. You would have to have almost perfect precision to get the ball to the top, let alone to have it stop dead-balanced. The same is true with the bomb. If you could reverse every atom and particle with suf-

ficient accuracy, you could make the explosion products reassemble themselves. But a tiny inaccuracy in the motion of just one single particle, and all you would get is more junk.

Here's another example: drop a bit of black ink into a tub of water. The ink spreads out and eventually makes the water grey. Will a tub of grey water ever clear up and produce a small drop of ink? Not impossible, but very unlikely.

Boltzmann was the first to understand the statistical foundation for the second law, but he was also the first to understand the inadequacy of his own formulation. Suppose that you came upon a tub that had been filled a zillion years ago, and had not been disturbed since. You notice the odd fact that it contains a somewhat localised cloud of ink. The first thing you might ask is what will happen next. The answer is that the ink will almost certainly spread out more. But by the same token, if you ask what most likely took place a moment before, the answer would be the same: it was probably more spread out a moment ago than it is now. The most likely explanations would be that the ink-blob is just a momentary fluctuation.


Actually, I don't think you would come to that conclusion at all. A much more reasonable explanation is that for reasons unknown, the tub started not-so-long-ago with a concentrated drop of ink, which then spread. Understanding why ink and water go one way becomes a problem of "initial conditions". What set up the concentration of ink in the first place?

The water and ink is an analogy for the question of why entropy increases. It increases because it is most likely that it will increase. But the equations say that it is also most likely that it increases toward the past.

To understand why we have this sense of direction, one must ask the same question that Boltzmann did: why was the entropy very small at the beginning? What created the Universe in such a special low-entropy way? That's a cosmological question that we are still very uncertain about.

I began telling you what my favourite explanation is, and I ended up telling you what my favourite unsolved problem is. I apologise for not following the instructions. But that's the way of all good explanations. The better they are, the more questions they raise.

• For the remaining 190 responses, we suggest you visit edge.org – and be prepared to spend a while there. **PM**



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LAMBORGHINI AVENTADOR J

LET'S NOT MEET HALFWAY

Lamborghini says the one-off Aventador J (that's J for Jota, harking back to that 1970s super-Miura) is its most uncompromising super sports car. Yet it is fully street legal.

For a start, the Aventador is what the Italians call a barchetta, which means 'little boat'. In essence, it is an open roadster. This is a car for the purist: no roof, no air-con, no sat-nav and no windscreen – just tiny wind deflectors. Tiny, but big enough to ensure that you cut through the air at 300 km/h without so much as ruffling your coiffure.

Based on the Aventador LP 700-4, the J uses innovative tech such as forged composite carbon fibre, pioneered on the Sesto Elemento. The material is used in construction of the seats, which are covered in more carbon fibre: a patented CF-based textile called CarbonSkin. And, like the LP 700-4, it has a 515 kW 12-cylinder engine – powering significantly less weight.

Fibre taken further. The Aventador J is the first vehicle to use patented CarbonSkin. It is made of woven carbon fibres soaked with a special epoxy resin that stabilises the fibre structure and keeps the material soft. Effectively, it moulds to a shape. Although CarbonSkin is used to clad the cockpit and parts of the seats, Lamborghini has suggested that it could even be used for high-end clothing.





2012 HONDA INSIGHT

CLEANER THAN EVER

Honda says it's created the cleanest and most economical Insight so far, with engine tweaks largely responsible for cutting fuel consumption to 4,3 litres/100 km (combined) and CO₂ emissions to 103 g/km. Aero efficiency improvements include a new grille design and a slimmed-down rear. A beneficial side effect of trimming the roof spoiler for less drag has been to improve rear visibility.

Ride refinement also came in for some attention, with lighter, stiffer aluminium front lower suspension arms replacing the steel originals, and a new choice of tyre. Power is supplied by a 65 kW 1,3-litre i-VTEC engine with IMA (Integrated Motor Assist). IMA's compact electric motor slots in between engine and transmission and boosts total system output to 73 kW and 167 N.m.

Price: R272 500, including 5-year/90 000 km service plan.



AUDI CONNECT

WI-FI ON THE DRIVE

Up to eight users can be connected simultaneously to the world-first wireless hotspot in Audi Connect. Leaving aside for the moment the matter of wedging eight people into a family car, the new Audi system's ability to navigate using Google Earth imagery and Google Street View adds impressive depth to the conventional sat-nav setup.

Audi Connect will be launched in South Africa with the introduction of the new A4 range and will be offered on several other models. Connection to the Net will be via the car's UMTS car phone module; the in-car Wi-Fi network will stream data to occupants. Having Google Earth imagery integrated into the navigation system's map display will, says Audi, make orientation significantly easier. Another benefit: being connected to Google means instant access to a huge number of up-to-date points of interest.



NISSAN DELTAWING

RACING TESTBED

Unconventional looks are just part of the story with this Nissan-backed experimental Le Mans racer. A 1,6-litre DIG-T engine forms part of the set-up that is effectively a test bed for new road car technologies. Importantly, it is expected to halve the fuel consumption of the conventional opposition.

The Nissan DeltaWing weighs only half as much as a conventional racer – and has only half the drag.

Engine output of about 225 kW is expected to be enough to power the DeltaWing to Le Mans lap times between the LMP1 and LMP2 categories.

The car's layout is highly

unusual. According to Nissan, the driver sits well back in the car, almost over the rear axle. At the other end of a long, narrow fuselage are narrow twin front tyres, specially created for the car by tyre partner Michelin. The engine is rear-mounted.

As the car doesn't fit into any existing categories, it will



run as an experimental vehicle bearing race number 0 and will not be classified as a finisher.

THE CALL OF THE ROAD

ELECTRIC OPTIONS

As long as you've got the budget, there's never been a wider range of options for getting mobile. From the utterly conventional closed box with four wheels to the rather unconventional wind-in-your-face choices shown here, you can own the road. Even if your usual wheels of choice are attached to a chair. What's more, these designs are both powered by electricity.

MELEX ELECTROVEHICLES

Nissan's Leaf and the Tesla sports car have shown that electric cars don't have to look like a milk float or a golf cart. On the other hand, there is merit in a vehicle that's stripped of all unnecessary frills and styled much like... a golf cart.

But there's one big difference: these are street legal.

The new models from Melex are just the thing for leisure, estates, agriculture, hospitality, industry, impaired mobility, university campuses and security. Even, says Stuart Elliot of Melex, for eco-friendly commuting.

Their new street legal models, available in two- or four-seater configuration, have been through SABS homologation



and will be registered as L3 light passenger vehicles. Top speed from the 48 V/5 kW motor is a bracing 50 km/h and range is a very useful 100 km if fitted with the optional solar panel.

In addition to these units, Melex is also homologating a 14-seat bus that's been snapped up by a casino. Find out more at electrovehicles.co.za



SCOOTI FREEDOM CRUISER

Those confined to a wheelchair usually depend on a helper or on specially adapted vehicles to get around. The Scooti Freedom Cruiser provides an alternative that, besides being convenient, suggests that travel could be fun, too. A ramp allows easy access to the Freedom Cruiser's "load box". Once in position, the driver simply powers off. You need never leave your chair, in fact.

According to the local distributors, the Cruiser will be ENATIS approved and street legal (though it won't be allowed on expressways).

The Cruiser is able to load up to 150 kg. The tricycle layout uses 16-inch alloy wheels with nylon/rubber compound tyres, drum brakes and a parking brake. The 48 V motor sends 800 W to the rear wheels (forward or reverse is selectable) and is able to propel the Cruiser to a top speed of 35 km/h. Range is between 55 and 65 km, with a charge time of 6-8 hours at 220 V. It should be quite nippy, too: turning circle is 3,8 metres.

Price: R43 995, including free delivery in SA. To find out more, see scooti.co.za

LEXUS RX HOT STUFF

Sportier performance profiling and a more macho look are key elements of the new Lexus RX launched at Geneva and due in South Africa mid-2012.

In addition to an aggressive restyle that adopts Lexus' family cues, the RX450h hybrid gets Sport mode, and there's an F Sport specification with running gear optimised for performance as well as individualised trim. Sport mode is specifically tuned for more electric motor power, at the same time sharpening throttle and steering responses and toning down stability and traction control to hand more control to the driver.

Touch to activate. Lexus' second-generation Remote Touch Interface multifunction control device now features the world's first slide-type joystick control

mechanism. It functions like a computer mouse: to select enter, just push the controller. Also, the multimedia system's full colour LED display now has multiscreen capability to allow three simultaneous independent displays, such as map, vehicle information, audio, navigation input, air-conditioner functions and incoming call.



TOYOTA FT-BH PUSHING THE ENVELOPE

Using feasible, commonly available technologies, just how far, practically speaking, can we develop today's hybrids? Toyota asked the question and answered it with the FT-Bh concept shown at Geneva.

At just 800 kg, with a 0,235 drag coefficient (typical minicar equivalent: 0,29) and a high-efficiency two-cylinder 1,0-litre powertrain, it averages 2,1 litres/100 km and 49 g/km of CO₂ emissions. Yet this is a vehicle of real-world proportions, with adequate room for occupants.

The Toyota engineers concentrated their energies on weight, drag, powertrain efficiency, electricity saving and heat management.

High-tensile steel, aluminium and magnesium helped cut the weight to 786 kg. The spinoff, says Toyota, is less load on the

overall structure, so other components – including the engine – could be made smaller. Not immediately obvious, but crucial, are aero improvements. These include air curtain intakes in the nose, streamlined wheels, an air outlet slit in the rear and an underfloor spoiler. Some unconventional solutions to conventional methods were used: cameras instead of airflow-muddling mirrors, and latches instead of doorhandles. The car uses 45/55R18 low rolling resistance tyres.

Electrical components were specially chosen for their efficiency – LED headlights, for example – and thermally optimal materials include special glass and paint. To further save energy, the air conditioning is directed only to where people are sitting.



2012 HYUNDAI SANTA FE

STORM BREWING

Set for a world launch at the New York show, the third generation of this crossover may be based on Hyundai's "fluidic sculpture" style but is inspired by its own theme, which the company calls Storm Edge. Its main design elements are refinement, smartness and practicality. Whatever, the Santa Fe takes the SUV image firmly into the urban space and is said to hint at the design direction for Hyundai's next-generation SUVs. It's expected to reach here early next year.





RENAULT CLIO WIRED

For 2012, the Clio is all about getting connected. To tune in to today's trendy urban lifestyle, Renault has revved up the model range and included features such as a standard Parrot Bluetooth system on the new entry-level 1.6 Yahoo! (we kid you not). Higher up, the top-end 1.6 Avantage model gets integrated Bluetooth and TomTom LIVE integrated satnav. The Yahoo! also gets an MP3-compatible radio/CD player with AUX in. In case the more mature among you are feeling a little technologically challenged by all of this geekspeak, on a more practical rands-and-cents note, the Clio's service plan has been stretched to four years and 60 000 km. And, of course, the standard engine is the 83 kW 1,6 with 5-speed manual (a 4-speed auto is optional on the Avantage).

Prices: from R159 900.

SUBARU EYESIGHT

SEEING IS BELIEVING

Subaru has broadened its EyeSight driver assist system to the North American market. According to Subaru, EyeSight is the first device in the world to solely use stereo camera technology to detect objects in front of the car. These objects include pedestrians, cyclists and other vehicles. Incorporated in the system are Pre-Collision Braking Control and Adaptive Cruise Control with all-speed range tracking and Lane Sway Warning. Sales of EyeSight models have accounted for 9 in every 10 Legacy and Outback sales in Japan, where it was launched.

Meanwhile, the jointly developed Subaru BRZ/Toyota 86 (below) has started trundling off a production line once used for Subaru's minicar range. The same facility is also expected to start producing the Subaru Impreza by next year.



TYRE TECH

Those black rubber doughnuts connecting your car (or bike, for that matter) to the road are sometimes a lot more influential than we give them credit for. Of course, they're a vital part of ensuring we have a safe, comfortable ride. But they are also important in ensuring a quiet ride – for us as well as those around us. And their effect on fuel economy is unquestioned.

At the Geneva Motor Show this year, Goodyear showed some tech concepts that could soon be coming to a road – or a planet – near you.

SHHH...

As the whine of electric motors supersedes the clatter of diesel engines in noisy inner cities, engineers from Goodyear's Innovation Centre in Luxembourg are looking at ways to drop the noise floor even lower through tyre technology.

The EU's CityHush project is proposing noise-limited quiet zones (Q-Zones) in five cities where only electric vehicles will be allowed. It's expected that overall noise levels will drop by about 15 dB, or even more around parks.

How can tyre makers help? Road noise isn't just about the road surface. It is also dependent on tyre dimensions, materials and construction and tread pattern. These parameters affect both the volume and the frequency spectrum of road noise. And it's these that were juggled to produce a quiet concept tyre for EVs shown at Geneva (right).

Goodyear also exhibited Air Maintenance Technology (top right), which keeps tyres optimally inflated without external pumps, electronics or driver intervention. The company says research has shown that underinflated tyres worsen fuel economy by between 2,5 and 3,3 percent.



WHERE THE RUBBER MEETS THE PLANET

The Spring Tyre is engineered to withstand the harshest environments on the Moon, says Goodyear, and possibly the toughest places on Earth. (We can think of a few roads that could test that confidence.)

Developed in conjunction with Nasa, the Spring Tyre is an advance on the wire mesh tyre previously used on planetary rovers, also co-designed by Goodyear. The new design has 800 load-bearing springs and is able to carry heavy vehicles.

Its spring design contours to any surface for maximum traction. It's highly efficient, because all the energy used to deform the tyre is returned when the springs rebound. Because of that, it won't generate heat like a pneumatic tyre would, the company says.

Naturally, because no inflation is involved, the Spring Tyre simply shrugs off pothole impacts. At the same time, its combination of flexibility and stiffness provides a plush ride.



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BMW 3 SERIES HEADS UP

The car that defined the compact sports sedan has thoroughly grown up. It now even offers decent accommodation in the rear.

In its latest iteration, the 3 comes with the usual blend of performance (Twin-Power Turbo engines throughout), sporty suspension tuning and tech (full-colour Head-Up Display, Driving Experience Control with Eco Pro mode). There's an option of an 8-speed auto gearbox, too.

Now into its 6th generation, the 3 Series is bigger all round. That size is most felt in the rear – most notably the effect of the 93 mm increase in over-all length and 50 mm in wheelbase. Yet, bucking the trend in today's safety-conscious (and therefore bulkier and heavier) designs, the new car is a massive 40 kg lighter than the outgoing version.

Available engines are diesel and petrol 6-cylinders and new turbo Fours in the 328 and 320. Under BMW's EfficientDynamics "green" tech umbrella, the new 3 gets Auto Start-Stop, Brake Energy Regeneration, Optimum Shift Indicator and ancillary activation on demand – including automatically disengaging air-con compressor.

New for 2012 is Eco Pro driving mode, which helps stretch fuel economy.

Safety and driving aids besides the Head-Up display range from a bird's-eye perspective display of the vehicle to active cruise control with lane departure warnings and camera-based collision warning.



BENTLEY EXP 9 F

DON'T SPARE THE HORSES

Bugatti's much-quoted line about Bentley building the world's fastest trucks hasn't stopped echoing since the unveiling of the EXP 9F concept at the Geneva Motor Show.

Translating the Bentley styling DNA into a completely new category was never going to be easy, so the EXP (for experimental) looks unresolved from certain angles, commanding from others. That said, with this concept Bentley has made no secret of its desire to bring an SUV to production. Mechanically, at least, the 450 kW/800 N.m 6.0-litre twin turbocharged W12 engine guarantees the performance you'd expect of a Bentley. Alternative powertrains, including a hybrid, could be offered.

Bentley says its designers drew inspiration from the "visible engineering" of the company's racing heyday: the day-time running light apertures double as engine air inlets and feature a mesh-covered turbine fan design and rifled inner surface finish that is echoed in the

exhaust outlets. This wouldn't be a Bentley without the gentleman's-club ambience typical of the marque. That's no more evident than in the accommodation appointments: diamond-quilted leather, cooled compartment for champagne and glasses, and a two-piece tailgate that can be either a viewing bench or picnic table for those ultimate tailgate parties. At the polo, of course.

PM





The
Goose
chase

WIN a VIP experience

at the 2012 Vodacom Origins of Golf

Since its inception in 2004, the Vodacom Origins of Golf series has grown in stature with each passing year, and the 2012 edition promises to continue that trend. Apart from the total prize money of R3,6 million on offer for the professionals at the six tournaments that make up the series, the "Origins" is a wonderful opportunity for sponsors and guests to take part in what must be the most coveted Pro-am invite in SA golf – and to do so on six world-class golf courses around South Africa – namely, Simola, Zebula, De Zalze, Selborne, Sishen and the venue for the grand final, Fancourt. Two years ago, the series was dedicated to Ernie Els and dubbed "Origins goes Easy". This time around, it's in honour of another multi-Major winning, living legend of the local game – Retief Goosen. Welcome to the "Goose Chase"!

Tech-heads will be pleased to know that TaylorMade is once again the official equipment sponsor of the Origins series and will be using it to showcase the very latest golf technology – like the all-new R11S driver. It's bigger, faster, and the most "tunable" driver ever made, meaning that you can customise the face angle, adjust the loft on the face and maximise the centre of gravity of the titanium, 460 cm³ matte-white driver head to suit your personal swing. TaylorMade calls it "3D Tuning" and it's another big step forward for one of the game's most innovative brands.



The good news for you is that one lucky **POPULAR MECHANICS** reader will win a VIP experience at the Vodacom Origins of Golf "Goose Chase" taking place at Selborne from 22 to 24 August 2012. The prize includes three nights' accommodation with breakfast and dinner – and a full golf package of two rounds of golf, including caddie/cart halfway, lunch and the legendary Origins goodie bag of TaylorMade golf gear. And if you happen to play well enough to finish top 10 overall, you will automatically get a spot in the Fancourt final on 26-28 September 2012.

To enter, simply SMS Selborne + your name to 32697

Standard terms and conditions apply: no one from SAIL or RamsayMedia may enter. In addition, winners will be notified 24 hours after the closing date and need to inform RamsayMedia or SAIL if they are able to accept the prize and attend the event. Failure to confirm this within a further 48 hours will result in the prize being withdrawn and another winner being drawn. Winners require an official SAGA handicap and will be required to play off a maximum 18 handicap. The prize excludes transport to the event location. Winners agree to allow their image to be used in RamsayMedia magazines and websites. Competition closes 30 July.

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The Goose
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Rules: The Ford Focus competition ends on 31 August 2012. Entrants must be contactable by telephone. The winner must be over 18 years and be in possession of a valid driver's licence. The prize is not transferable, nor can it be converted into cash. The prize vehicle will be used at POPULAR MECHANIC's discretion for promotional purposes and selected editorial assignments during the campaign period (March to August 2012). The prize vehicle



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MKi9200 Bluetooth hands-free system from TruBlue. Dedicated to in-car calls and music, it features a 2,4-inch high-resolution TFT colour screen (visit www.bluetoothcarkits.co.za). Existing subscribers may enter by extending their subscription at a **35% discount**.

The all-new Ford Focus combines dynamic exterior design with a driver-focused interior, featuring a cockpit-style layout and superior craftsmanship. With its striking front end, sleek profile and athletic stance, this Focus enjoys sporty and contemporary styling while maintaining the comfort and practicality characteristic of the Focus brand.

Maximising sustainability was a primary goal for the all-new Focus. In addition to minimising CO₂ emissions through high-efficiency powertrains, weight saving and improved aerodynamics, the new technologies ensure that the Focus represents a green and sustainable vehicle choice. This holistic approach addresses the entire life cycle of the vehicle, from eliminating allergenic substances from the interior to incorporating recycled and renewable materials.

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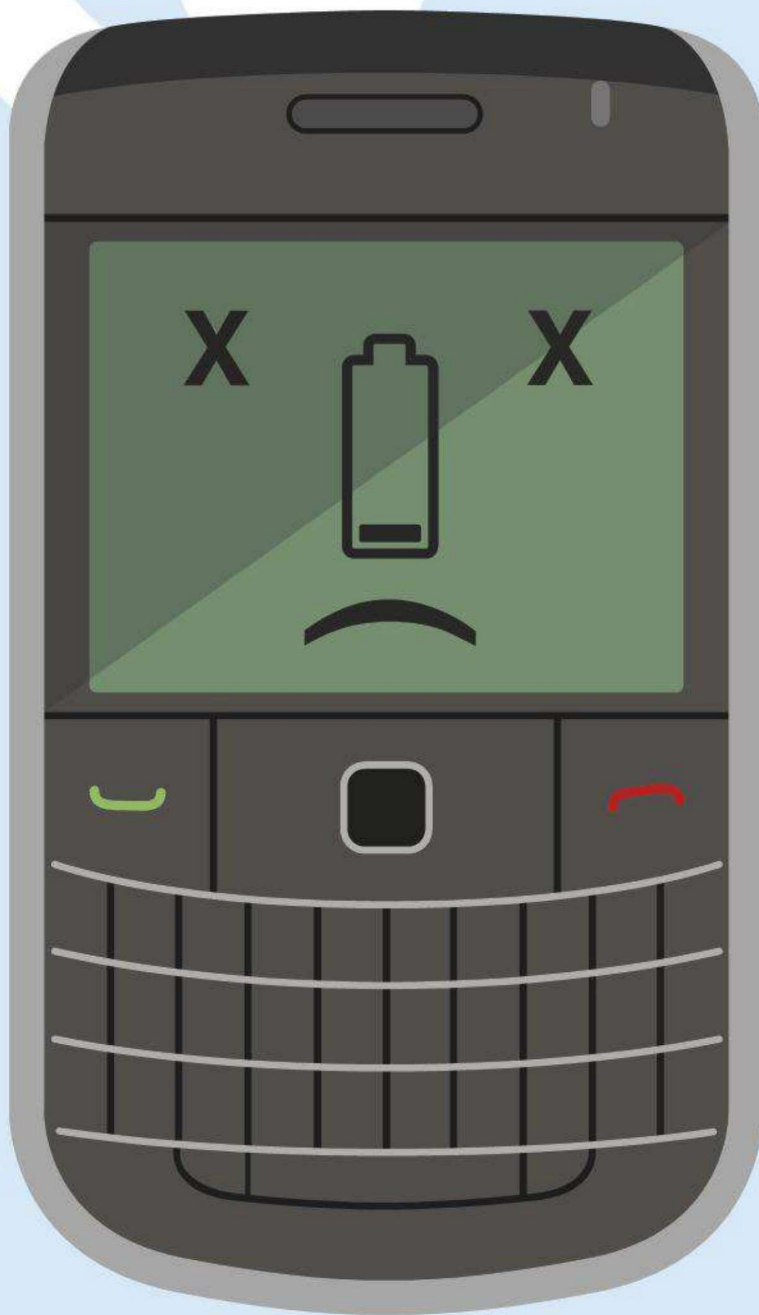
DIGITAL CLINIC

> BY JOHN HERRMAN



Battery death

Q I'd like to give my old mobile phone to a friend, but when I pulled it out of storage, the battery was completely dead. It was fine when I put it away. What happened?



A Lithium-ion batteries are the problem child of modern electronics. They leave your laptop juiceless after just a few hours. They send you hunting for power outlets at the least opportune times. They're the reason "sorry, my phone's about to die" has become as common a sign-off as "goodbye" in modern cellphone conversations.

Less obvious than low capacity is the problem of longevity. Lithium-ion and even newer lithium-polymer batteries have a nasty habit of losing capacity over time or, worse, dying altogether. Any battery issue is by definition a chemistry problem. In a healthy battery, ions flow freely between a cathode and an anode. Charging a battery forces ions from the cathode to the anode; using the battery reverses the flow.

Over time, this process wears out the cathode, which results in reduced capacity. A high-end lithium-polymer battery can lose about 20 per cent of its capacity after 1 000 charge cycles. Another way to think of this is to imagine that every time you recharge your laptop, you shave a few seconds off its maximum battery life. Erratic charging and heat speed up this degradation.

And batteries degrade even if you don't use them. According to battery-testing firm Cadex Electronics, a fully charged lithium-ion battery will lose about 20 per cent of its capacity after a year of typical storage. Increase the temperature to above 38 degrees – as on your car's windowsill, for example – and that number rises to 35 per cent.

On the other hand, an empty battery pack can eventually fall into "deep discharge", at which point the battery's protection circuit – intended to prevent power from reaching defective battery cells – is triggered. This leaves the battery unable to charge at all.

Your best bet for long-term battery storage is to run the charge down to 50 per cent, remove the battery from the device, and keep it cool. But even ideal storage conditions can leave you with a dead battery after three or four years.

TRASH TALK

Q My computer tells me that I'm running low on disc space. I've deleted files, but the messages won't stop.

A By default, "deleting" a file moves it to either the Recycle Bin (Windows) or the Trash (Mac OS). In other words, the files haven't been deleted – they've been sent

into limbo, to a special folder where they remain fully intact but can't be directly accessed. This is a blessing when you realise you've accidentally deleted an important file. More often, though, it's just a waste of space.

Going forward, to free up hard-drive space, right-click on the Recycle Bin or Trash icon and click Empty. Windows users can bypass the Recycle Bin by selecting a file, holding down Shift, and pressing the Delete key.

ABANDON SHIP?

Q I have a hunch my kids are pirating music, and I want them to stop. They claim it's no big deal. Should I worry?

A In 2008, the Recording Industry Association of America announced that it would be drawing down its lawsuits against file sharers, instead relying on Internet service providers to issue warnings. This gave some the impression that file sharing has become, if not legal, safe. It hasn't. Hosting and sharing copyrighted materials for free is still illegal, and looser enforcement doesn't change the fact that file sharers' identities are exposed.

BitTorrent, a popular file-sharing service,

exposes users' IP addresses to whoever might want to see them, be they copyright holders or law enforcement. Free download sites such as MediaFire are themselves vulnerable to lawsuits, which could result in the subpoena of user information – the biggest, Megaupload, was shut down by authorities in January. Getting slapped with a hefty lawsuit for

downloading files may be statistically unlikely, but it's not impossible.

It seems the message is getting out. We were told by someone who regularly sources (presumably pirated) e-books from a certain Web site that the site's download facility was suddenly removed without explanation. Now he's feeling slightly nervous. **PM**



TECH TACTICS

THE FLASH-FREE LIFESTYLE

With the rise of HTML5 video and native Web apps, Adobe's Flash browser plug-in is on its way out, and not a moment too soon. Here's how to switch off – but not permanently delete – this buggy, insecure, resource-hungry software.

FIREFOX

Download an extension called Flashblock from addons.mozilla.org, click on Install, then restart the browser.

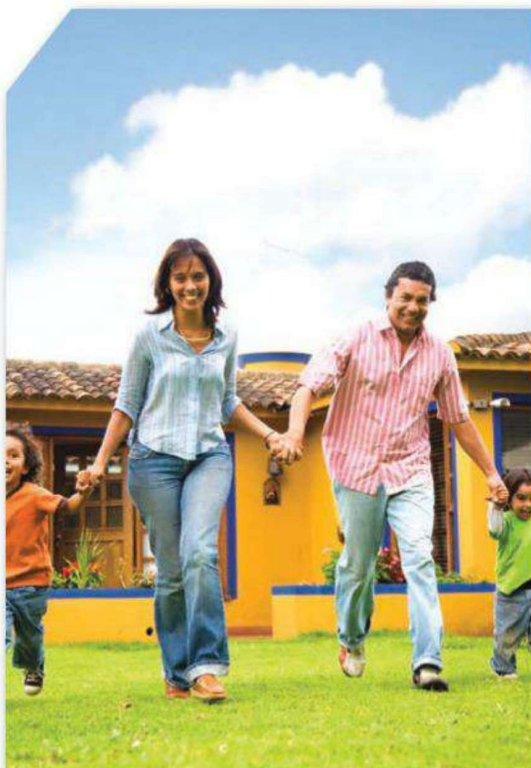
CHROME

Click on Preferences, Under the Hood, Content Settings, Manage Exceptions, and Disable Flash, then restart the browser.

IE 9

Click on Tools, Manage Add-ons, and Shockwave Flash, then select Remove All Sites.

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The Eskom *eta* Awards are putting energy efficiency on the map

Over 23 years ago, Eskom launched the *eta* Awards.

Back then, energy efficiency was a new concept; an awards ceremony that recognised and rewarded excellence in energy efficiency was an innovative approach to encourage and inspire energy efficiency.

Since then the awards have grown into South Africa's most prestigious energy efficiency awards. They now honour companies, individuals and young people across 10 categories.

Today, energy efficiency is the buzzword on everyone's lips. This has resulted in a huge upswing in the number – and the quality – of entries, according to Eskom's *eta* Awards organiser Annamarie Murray.

With entries for the 2012 awards having opened on 2 April 2012, Eskom is looking forward to enthusiastic participation across the various categories. Whether you're retrofitting your home to cut down your electricity bill or if your company is doing something great to reduce your carbon footprint, enter and you could win up to R30 000 for your bright idea.

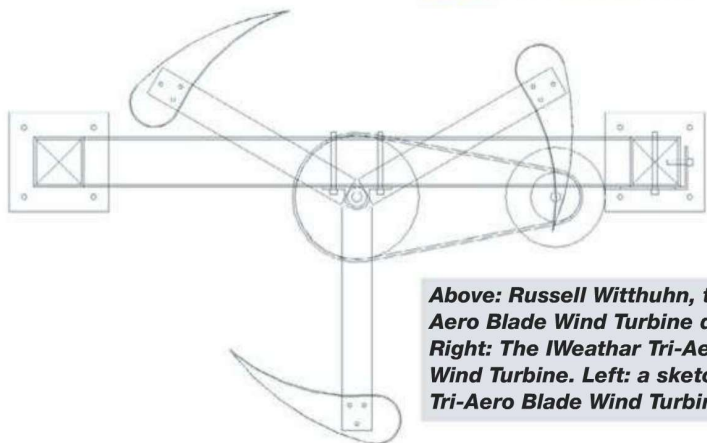
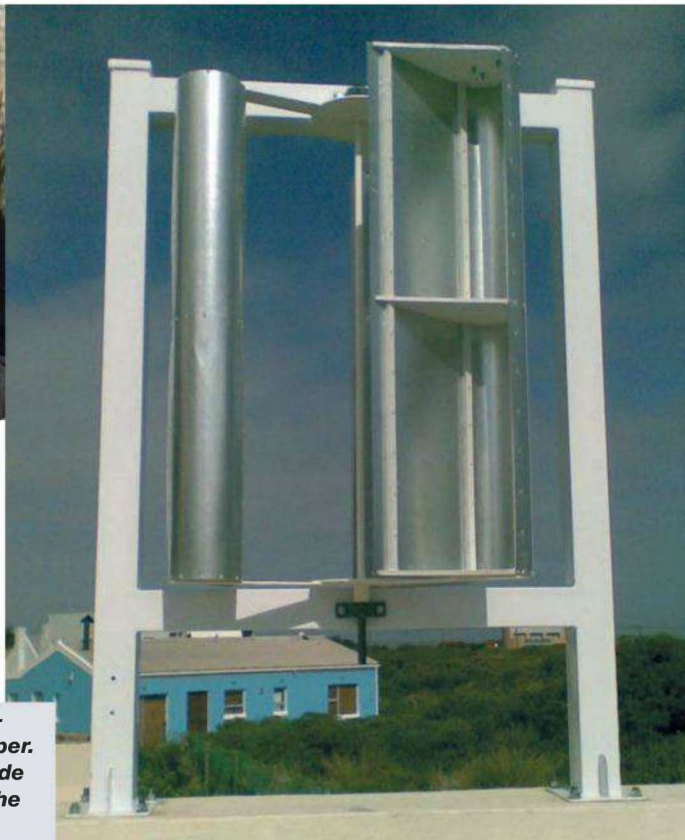
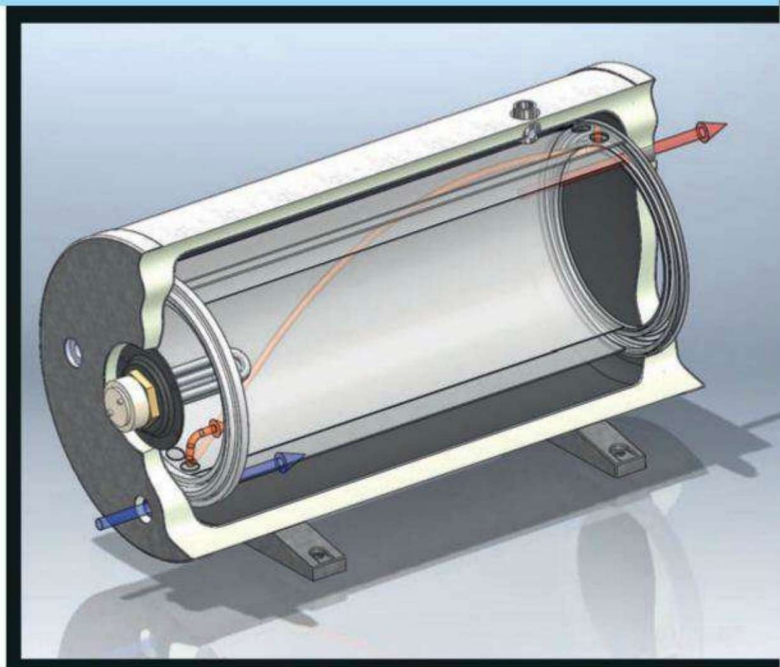
Murray says: "As more South Africans start to make small and big changes in their own lives to become more energy efficient,

we are seeing a growing number of fantastic entries. We hope that this year will be the same."

Last year saw some truly inspiring entries. One that really impressed the judges was IWeather's vertical wind turbines.

Russell Witthuhn developed the vertical Tri-Aero Blade Wind Turbine, which is specially designed to withstand the harsh weather conditions experienced on South Africa's coastline. He was runner-up in the innovation category in 2011 and hopes that his product will soon be seen in communities across the country.

Witthuhn says: "It can generate enough power to meet the energy needs of an average household fitted with a solar geyser and gas stove, but can also be adapted to



Above: Russell Witthuhn, the Tri-Aero Blade Wind Turbine developer.
Right: The IWeather Tri-Aero Blade Wind Turbine. Left: a sketch of the Tri-Aero Blade Wind Turbine

in energy efficiency: the 23rd annual *eta* Awards, sponsored by Eskom



Above: Nicholas Nouwens, inventor of a highly innovative multi-cavity water heater system
Above left: A diagram of Nicholas Nouwens' innovative geyser.

Below: Meinhard Fourie shows off his innovative energy efficient pool pump.



feed into the power grid to add capacity to Eskom's supply. Over the course of a month, the turbine can produce around 500 kilowatts of electricity."

Witthuhn is also excited about the potential to use the wind turbines in low income communities not on the national power grid. He explains that the turbine can be installed and maintained by almost anyone with the right training and that thereafter can be turned into a

business supplying power to businesses or communities.

Another entry that really made a splash was Meinhard Fourie's pool pump, which could significantly reduce the energy required to run the average swimming pool.

In South Africa there are approximately one million swimming pools. These each require 0,6 W of electricity to be kept clean and sparkling. This total energy required could power 500 000 average households.

Meinhard saw that something needed to be done and consequently spent two years developing an energy efficient pool pump. The result is a pump

that is both cost effective and energy efficient, ticking all the right boxes for the South African consumer.

Another entry and innovator that really stood out in 2011 was a highly innovative geyser concept. Nicholas Nouwens, a graduate from the University of Pretoria, developed a multi-cavity water heater system that dramatically increases geyser efficiency by subdividing a geyser's water tank.

Nouwens first started working on his system in the final year of his engineering degree. His invention can reduce energy consumption by 6,5 per cent while delivering between 50 and 70 per cent more hot water.

"This is the first locally created innovative improvement on hot water stores for domestic water heaters. It has the potential for a wide social impact because it is versatile, affordable, locally developed and not geared to any particular market at the exclusion of others. It is also safe, well researched and shown to work.

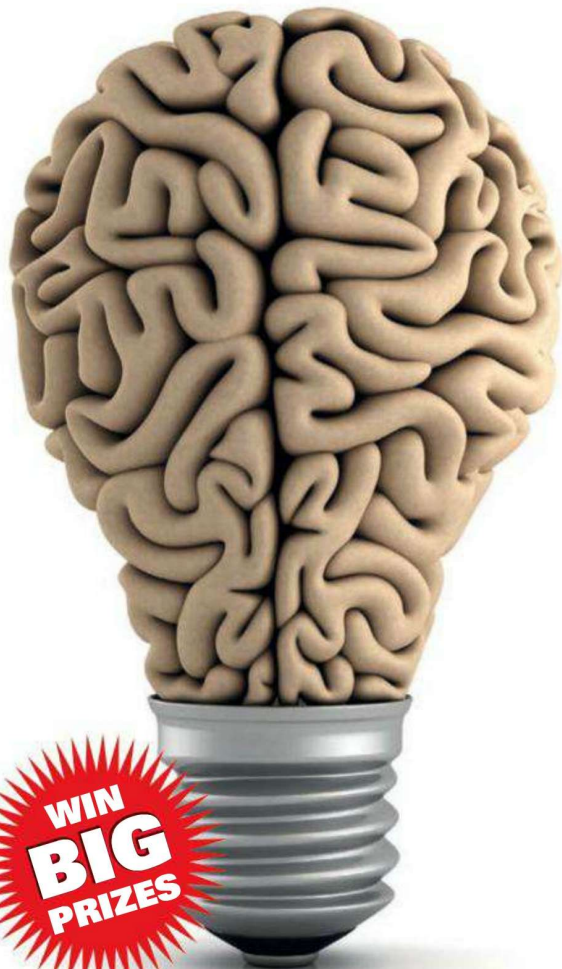
"The challenge lies in shifting mindset and earning the stamp of approval from water heater manufacturers," concludes Nouwens.

If you've been tinkering around in your workshop and have found an energy efficient solution to a common residential need, or perhaps found a way for your company to produce more with less energy, let us know. You could be receiving R30 000 at this year's awards ceremony.

More about the *eta* Awards

The prestigious annual *eta* Awards, sponsored by Eskom, are aimed at recognising excellence by individuals and companies in the field of energy efficiency. To find out more about how you or your company can enter the *eta* Awards, visit www.eta-awards.co.za

One *really* good idea



THAT'S ALL IT TAKES to enter our competition and stand a chance of becoming South Africa's **Inventor of the Year** for 2012. In the coming weeks and months, we'll be calling for entries from all corners of the country as we prepare for our annual feast of inventive excellence in four categories: **Stepping Up** (high schools), **Breaking Ground** (university students), **Emerging Genius** (previously disadvantaged and minimally resourced entrants) and **Cutting Edge** (open to anyone).

Generous prizes are on offer in each category, and the overall winner will be declared South Africa's **Inventor of the Year** for 2012, walking off with a floating trophy plus a large cash prize in recognition of his or her achievement.

As before, the competition forms part of a larger initiative that encompasses an inspiring conference – expect something very different this year – plus a mini-expo of cool technology and the chance to mingle with some of the smartest people you'll ever meet. Oh, and did we mention that prize money would be

generous? We'll be releasing full details in the near future.

Rules? There are a few, but we'll do our best to make it as easy as possible. For example, your invention must be your own, original work, and it must be fresh (in other words, don't submit something that was featured in your local newspaper 20 years ago). It should also serve a genuine purpose: whereas you might believe a combination nose-hair clipper and tea strainer is exactly what the world needs, you're probably wrong. And finally, keep it real: your rough sketch of a fusion-powered bicycle won't cut it.

What's your next move? Start working on that invention right now – and *do your homework*. Research it on the Web to make sure your invention isn't replicating someone else's idea (you'd be surprised), gather all the relevant information on your target market, and if possible, build a working prototype (there's nothing quite as reassuring to a judging panel as an invention that clearly works). Then, when we open for entries, you'll be ready and waiting.

STEPPING UP

BREAKING GROUND

EMERGING GENIUS

CUTTING EDGE



At last year's awards ceremony, bioengineer Dr George Vicatos (third from right) won R50 000 in cash – he later shared it with his two collaborators – plus the title *Inventor of the Year* for his development of a versatile and potentially life-changing facial reconstruction system. From left: PM editor Alan Duggan, Gerard de Vaal (runner-up, *Cutting Edge*), Kenneth Mia (*Special Merit Award, Emerging Genius*), entertainer Peter Greenwall, George Vicatos, Lucky Mokalusi (*Special Merit Award, Emerging Genius*) and Jamii Hamlin (*winner, Going Green*).

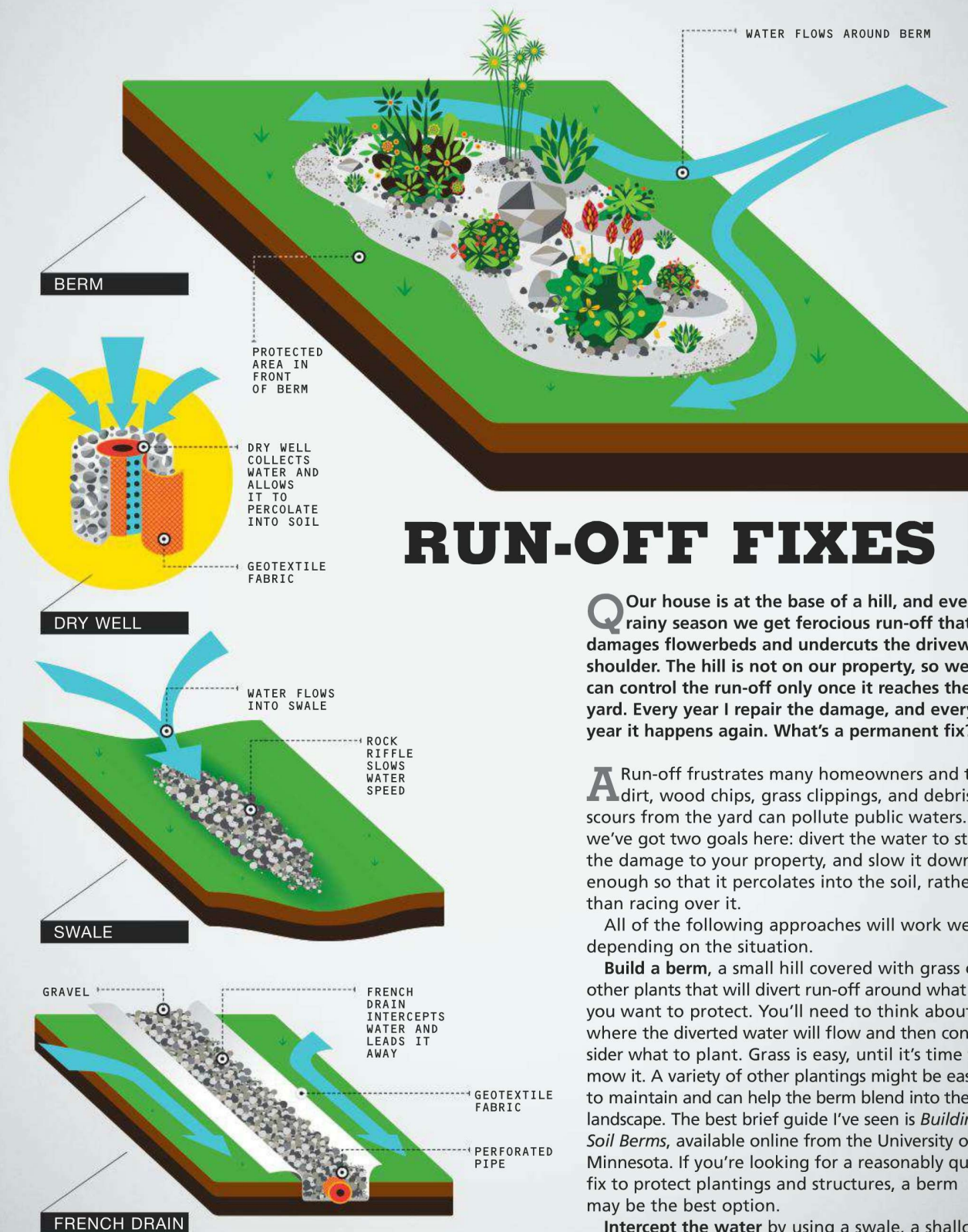
Popular Mechanics

BE THE FIRST TO KNOW

DIY HOME

> BY ROY BERENDSOHN

Q+A



RUN-OFF FIXES

Q Our house is at the base of a hill, and every rainy season we get ferocious run-off that damages flowerbeds and undercuts the driveway shoulder. The hill is not on our property, so we can control the run-off only once it reaches the yard. Every year I repair the damage, and every year it happens again. What's a permanent fix?

A Run-off frustrates many homeowners and the dirt, wood chips, grass clippings, and debris it scours from the yard can pollute public waters. So we've got two goals here: divert the water to stop the damage to your property, and slow it down enough so that it percolates into the soil, rather than racing over it.

All of the following approaches will work well, depending on the situation.

Build a berm, a small hill covered with grass or other plants that will divert run-off around what you want to protect. You'll need to think about where the diverted water will flow and then consider what to plant. Grass is easy, until it's time to mow it. A variety of other plantings might be easier to maintain and can help the berm blend into the landscape. The best brief guide I've seen is *Building Soil Berms*, available online from the University of Minnesota. If you're looking for a reasonably quick fix to protect plantings and structures, a berm may be the best option.

Intercept the water by using a swale, a shallow ditch with gently sloping sides. You can also use a French drain, a gravel-filled trench that may have a

perforated pipe at the bottom. New products include the EZ-Drain, which consists of a perforated pipe and plastic beads encased in a tube of landscape fabric. The fabric surrounds the pipe like a sock and prevents dirt from infiltrating and filling up the pipe or the air spaces between the beads. Because French drains handle water that is moving not just over the soil but through it, they're the best solution for keeping water out of a basement.

Route the water into a dry well. As the name suggests, this is a hole in the ground that remains dry most of the time. However, when water is flowing, it can be routed to the well by a swale or roof downspout. Dry wells are particularly helpful in a spot where downspouts are flooding a large paved area or when you're coping with run-off from a large roof. Finally, you can dig a dry well in any low area where a big puddle tends to form.

Grade broad surfaces to direct run-off away from houses, sheds, outbuildings, and patios. In most cases this requires a professional excavator or expensive rental equipment. But it's almost always an essential step for correcting a flooded basement or crawlspace.

Replace impermeable surfaces such as concrete with permeable pavers and gravel. This can be expensive, but it's worth considering, especially if you're already replacing deteriorated asphalt or concrete.

A final word of advice is in order before you start swinging a pickaxe or hiring a Bobcat loader. Depending on what part of the country you're in, it may be subject to specific rules about landscape modifications that affect groundwater, even on a small scale. These regulations are more likely to apply if your house is close to a lake, stream, or seashore, but it pays to check requirements no matter where you live.

It's also smart to check with utilities in your area about your intent to dig. It may be useful to know the location of buried utilities, such as telecom cables, water lines and sewers.

FAST FLOORING

Q Are peel-and-stick floor tiles any good?

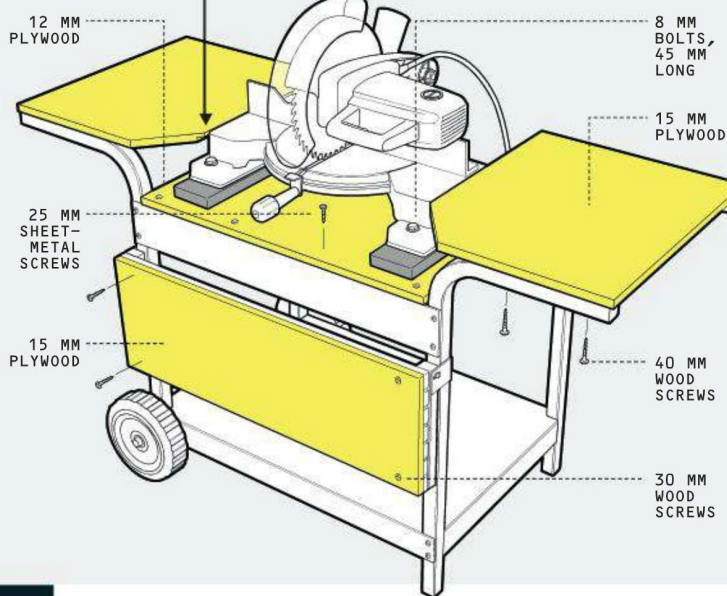
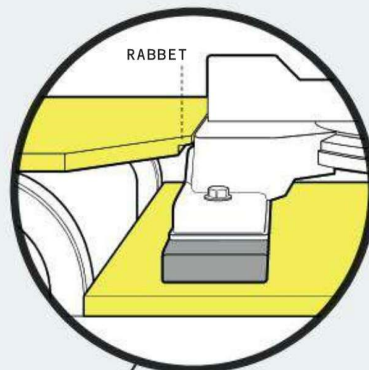
A Sure, peel-and-stick vinyl tiles are a great product and very DIY-friendly. You can reliably install them on top of plywood or, with some precautions, on concrete. If you're working with plywood, make sure it's rated for use as a subfloor. If the subfloor is rough timber or is plywood that lacks the requisite rating, or if you're not sure what kind of plywood it is, then install subfloor-rated plywood.



THE RECYCLER

MITRES À LA CART

Randy Dean runs a tight workshop in his home in Ignace, a town of 1 700 people – many of them loggers – in Ontario, Canada. Dean's work space is well outfitted for everything from welding to woodworking. He has always owned a mitre saw, but something about it bugged him. It just sat there. Putting the saw on wheels would improve its utility – almost anything is better on wheels – and it would be easy to do. Dean started with an old braai cart and ended up with a rolling mitre saw. Now, that's a mobile device.



HOW TO MAKE IT:

Strip off the braai body, its plumbing, and the control panel. Rip and crosscut 12-mm and 15-mm plywood panels to make a base and extension wings to flank the saw.

The top of the saw's table should be flush with the extension wings, so you'll need to cut wood blocks to

position under the saw to raise it up. Cut the blocks to size, place them beneath the saw, mark and drill the mounting holes in the blocks, and bolt the saw through the table to the cart. You may also need to cut a rebate in the wings to let them fit neatly over any projections in the

saw body.

Next, attach the wings to the cart's sheet-metal tubing using 40-mm wood screws. If your cart is equipped with a slatted shelf on the front, you might opt to keep it. Dean screwed a piece of plywood over the slats to provide an additional work surface.

The tricky thing about concrete is that any moisture vapour or groundwater that comes through will lift the tiles. As a test, use plastic tape to seal an 450 x 450-mm piece of clear plastic sheet to the floor

and leave it in place for 24 hours. If you see condensation on the underside of the plastic, you can't install the tiles on the floor. If the plastic stays dry, the tiles will probably work. No guarantee, though. **PM**

New in South Africa

The LED LENSER™ X range

The X Series offers lamps for those who like superlatives. With these lamps, illuminating large areas and achieving impressive ranges are child's play.



The Torch that inspired a world record

On Sunday 25th September 2011 LED Lenser officially unveiled the World's Largest Torch. The LED (Light Emitting Diode) torch, nearly 4 meters in length and weighing 216kg, incorporated 19 high-end LEDs that generated an awesome 100,000 lumens of light. On hand to witness and verify this extraordinary testament to LED Lenser's world-class engineering skills was a representative from the Guinness Book of World Records.

This record breaking torch was not only developed with size in mind but also to highlight energy efficiency as well. Today's LED lights are up to 13 times more efficient than conventional light bulbs and last 1000 times as long. If a luminous flux of 100,000 lumen is supplied to the torch, it consumes 1000 watts of energy. In comparison, 250 conventional 40-watt light bulbs consume 10,000 watts of energy.

The design of the World's Largest Torch by LED Lenser is based on the powerful and widely available LED LENSER X21 which features a Dynamic Switch, Speed Focus and the patented Advanced Focus System. Powered by just four standard D-cell batteries, the X21 emits a breathtaking 1000 lumens of light that has a range of around half a kilometer.



Unveiling the worlds largest torch.
Supersize this!!!

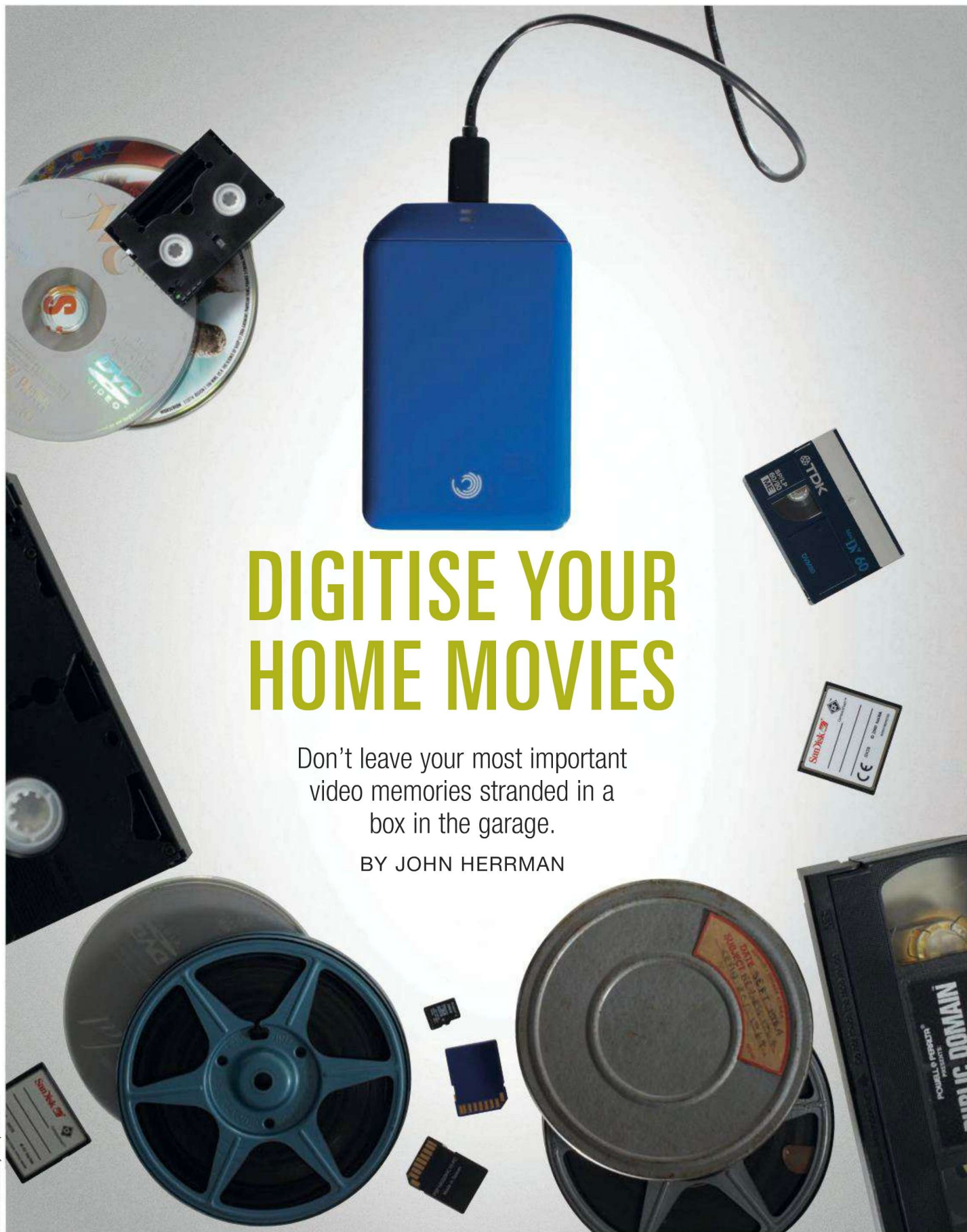
* Luminous flux (lumens) and max beam distance (meters) are measured in the brightest function when switching on with new set of fresh alkaline batteries.

These are average values and may vary +/- 15% depending on type of chip and batteries.

** Average hours of burning life as measured in the least energy-consuming mode and until residual luminous flux amounts to 1 lumen.

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DIGITISE YOUR HOME MOVIES

Don't leave your most important video memories stranded in a box in the garage.

BY JOHN HERRMAN

➡ **As video content gets old**, it gains sentimental value. As film and video media get old, they fall apart. This is the paradox at the centre of our movie collections: it's the priceless images – the first steps, the trips down the aisle – that have greatest risk of loss.

Reel-to-reel 8 mm tape has a typical shelf life of about 20 years, at which point the threat of magnetic instability, tape deformation and general chemical breakdown becomes unavoidable. Likewise, VHS cartridges begin to deteriorate after only a decade. Recordable CDs and DVDs, despite their apparent durability, can fall prey to oxidation after just a few years – data is stored on a delicate metal film at the top of the disc, not in the plastic.

Hard drives and solid-state storage won't last forever, either, but at least they give you control. With your movie collection stored on a computer, it joins a maintainable mass of data, part of your ongoing computing experience. Once in the digital realm, movies can be copied and recopied. They can be uploaded to the cloud. Most importantly, they can be backed up.

FROM THE GARAGE TO THE HARD DRIVE

➡ Before you get started digitising, you'll need to assess the scale of your project. Digitising tape or film is a real-time process; it takes as long to convert it as it does to watch it. Digitally archiving more than a dozen hour-long videotapes or more than a few reels of 8 mm film is a big undertaking, so if you're facing boxes and boxes full of dusty film, you might need to get professional help.

US services such as DigMyPics and Digital Memories will digitise a variety of film and videotape formats, including 8 mm, for a rate of about \$20 per transfer. This can quickly get expensive, but you're paying for more than just speed and ease – these companies are well-equipped to deal with delicate, volatile old media. They also have well-maintained playback and recording equipment designed to tolerate imperfection and deal gracefully with failure.

DigMyPics, for example, scans each reel frame by frame, projecting light through the film and on to a specially designed



KNOW YOUR STUFF

VIDEO PLAYBACK 101

You don't spend hours converting old videos just to leave them languishing on a hard drive. Here are four ways to watch your new digital home-movie collection.

 <p>PS3</p>	<p>Plays > H.264, MPEG-4, DivX. Special talents > Compatible with the .mkv format, which is common for HD video.</p>
 <p>iPAD</p>	<p>Plays > H.264, MPEG-4, Motion JPEG. Special talents > Streams media from a PC with an app called StreamToMe (or, in our case, Air Video).</p>
 <p>XBOX 360</p>	<p>Plays > H.264, MPEG-4, Windows Media > Special talents > Connects to any Windows PC with Windows Media Centre.</p>
 <p>SMARTPHONE</p>	<p>Plays > H.264, MPEG-4. Special talents > Streams video from PCs running a free app called TVersity, even over 3G.</p>

image sensor, ensuring consistent transfer quality. So if your home videos are both old and priceless and you haven't viewed them in years, you should err on the side of caution; not only are your reels and cassettes weakened by age, but your vintage playback hardware probably isn't at its best, either.

That's not to say you can't digitise tape and film yourself. If you know your home movies to be in decent shape and your playback hardware is in working order, digitising personal video is a uniquely gratifying personal project. Think of it less as a chore than as a chance to revisit your life's greatest stories.

DIGITISING FILM

➡ Low-tech storage media call for a low-tech conversion technique. As a consequence of their design, reel-to-reel projectors' only output is the projection itself – there are no ports to plug anything into; just the projected image. The process of digitising old film, then, is really an act of re-recording.

Set up your projector in a dark room, and make sure your projection surface is smooth, white, and less than a metre wide – a closer projection will ensure sufficient brightness and full-colour reproduction. (If you don't have a projector, there's a steady supply of affordable variable-speed models on eBay.) Set up a digital

video camera – an HD flip-style cam or even a high-quality smartphone camera will do – and position it on a stable surface close to the side of the projector. Begin recording some sample footage.

It's likely that you'll notice some flickering in the image; this can be remedied by adjusting the speed of the projector. The perspective of the film will be slightly skewed, of course, but the effect can be minimised by cropping the frame slightly. If you are recording directly from a projector's speaker rather than via its line output, check that your camera's mic isn't picking up too much mechanical noise.

The resulting footage should be clean and vivid but not necessarily without quirks. Nearly all video cameras, especially cheaper ones, meter light automatically and continuously, so the image may suffer from brief moments of overexposure. If you can manually adjust your camera's exposure, setting it to a fixed exposure is ideal.

As with reel-to-reel film, the digitisation process for VHS and most tape-based media calls for both old and new equipment. For this inter-generational marriage, you'll need an analogue-to-digital converter (ADC). Among the most affordable and reliable ADCs is the Elgato Video Capture dongle, a squid-like USB accessory that can be found online for under R800. It lets you connect older playback

equipment – VCRs, camcorders – to your computer.

After you connect the Video Capture cable to your computer and video source, you'll find the recording process is highly guided. Elgato's software will prompt you to adjust the recording parameters to your liking (the H.264 video format in standard definition is generally fine) and then ask you to hit Play on the video source.

When the recording is finished, you'll have the option to export files to iTunes or Windows Media Player. Instead, simply save them to a folder. You'll still be able to play the files in your media player of choice, but this way they won't get hidden deep in your computer's file system where they might get lost or be forgotten.

Archiving, or "ripping", DVD video is a three-click process. A free application called HandBrake, available for both PC and Mac, will automatically recognise a DVD video when the disc is inserted into the computer. Before clicking Start, select the Normal quality setting under the Regular tab on the right side of the app. The rip and conversion should take between 5 and 30 minutes and will produce an archival-quality H.264 video file.

To estimate your storage requirements, assume you need about 75 megabytes for every 10 minutes of SD footage, and 125 megabytes for every 10 minutes of HD footage. In South Africa, the cost of storage has fallen to around R1 per gigabyte, down from about R7,50 in 2005. One-terabyte external hard drives can be purchased from your local computer shop for around R1 000 and up (prices and availability were severely affected by last year's floods in Bangkok, where most hard drives are manufactured).

HandBrake is also useful for converting digital video recordings in less common formats – such as Sony's and Panasonic's AVCHD – to an H.264-based .avi file, a format that will probably be far better supported into the distant future. (H.264 also plays well with current gadgets, from smart TVs to smartphones.) Make sure to change HandBrake's conversion settings to HD for newer digital video; otherwise you'll lose video quality.

SAVING FOR THE FUTURE

By the time you've finished digitising your videos, you'll have amassed a folder full of files. Capturing the video is the hardest step of the archiving process, yes – but it's not the last.

Long-term video storage in the digital

age is fundamentally new. The University of Southern California Shoah Foundation Institute, which maintains a collection of more than 51 000 historically invaluable video testimonies by Holocaust survivors, recently converted its library from tape to digital video; 234 000 tapes were fed through dedicated digitisation stations, converted to digital video, and sent to be stored in a facility that looks more like a Google data centre than a library.

Although USC's project was far bigger than any of ours, its procedures are instructive: the university didn't just digitise its video; it backed it up.

Backing up video doesn't necessarily mean buying a stack of new hard drives or a dedicated backup system such as Apple Time Capsule. It's really just a matter of

duplication: you haven't really archived your video until you've made two independent copies of it. For newly converted videos, that can mean a number of things. You can simply store your video files on both your computer's hard drive and an external USB hard drive, or you can upload your video files to YouTube or Vimeo, where they can be designated as Private.

Should one hard drive fail, you can immediately copy your videos to another. If, say, Google decided to shut down YouTube – remember, we're thinking long-term here – you can re-download your videos from the site, upload them to another, or save them locally. This ongoing process guarantees more than peace of mind – it means that for the rest of your life, your video will be as easy to watch as it is safe. **PM**

LAB TEST

HOW FAST IS THUNDERBOLT?



Apple introduced the Thunderbolt port in 2011, but only now are we seeing a large-scale rollout of Thunderbolt peripherals. Apple says the standard is up to 20 times faster than USB 2.0. But that's a theoretical number. How fast is it in the real world?



TEST: We transferred a 2,7 GB movie file from an SSD-equipped MacBook Air to the drive over USB 2.0 and Thunderbolt. Then we transferred the same file using a PC with an internal SSD and a USB 3.0 connection.

RESULTS: Thunderbolt is fast, but nowhere near as fast as Apple claims. Our test file took 84 seconds to transfer from our MacBook Air to our GoFlex drive over USB 2.0. The same file took 33 seconds over Thunderbolt. Despite USB 3.0's lower speed rating (purportedly 5 gigabits per second), the file transferred in 35,2 seconds – close to parity with Thunderbolt.

VERDICT: Until the cost of the equipment comes down – the R400-plus cable is not included – Thunderbolt is absolutely not worth the price unless you're routinely transferring truly huge files. – **GLENN DERENE**

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CLIMBING *the* IRON WAY

BY JIM GORMAN | PICTURES BY JASON GOULD

CLICK, CLACK. Click, clack. The clatter of aluminium carabiners clipping and unclipping fills the air on this late summer afternoon.

Pendulous clouds drape the upper slopes of Spruce Knob, the highest peak in West Virginia, and threaten rain. At the moment, though, only a fine mist penetrates a canopy of oak and locust at the base of Nelson Rocks, where guide Josh Armstrong and I watch nine climbers, led by guide Jason Cain, scale a 30-metre quartzite cliff on ladder-like rungs anchored in the rock. Each climber wears a harness with a pair of carabiners on lanyards clipped to a steel safety cable that runs alongside the rungs. At 2-metre intervals, when a climber reaches one of the eyebolts that anchor the cable to the cliff, he or she detaches one carabiner from the cable, clips it back on the cable above the bolt and then does likewise with the trailing carabiner. Click. Clack.

"You're up," Armstrong says. He isn't a rock-climbing guide in the traditional sense. No rope runs reassuringly through his expert hands to my climbing harness. He can't catch me if I fall – and falls are heavily discouraged. Slipping off the metal rungs might cause more injury than a fall while roped and on belay in conventional rock climbing. "We don't have a dynamic rope to catch us, or someone on the ground to absorb the shock of our fall," Cain said before the climb. "We are falling on stainless-



FIXED RUNGS, CABLES, BRIDGES? SOUNDS LIKE SACRILEGE TO CLIMBING PURISTS. TO THE REST OF US, A VIA FERRATA (ITALIAN FOR 'IRON ROAD') MEANS A WAY TO REACH NEW HEIGHTS.

Don't look down!
The author finds sheer adventure on the cliffs of Nelson Rocks thanks to a network of steel hardware.

steel cable. Doesn't stretch much. These lanyards? Not going to stretch much. We can generate a lot of force with a fall. It's going to hurt. So no falls."

No falls. Okay. A familiar nervous anticipation overtakes me. I have a fair amount of experience on rock, though it's been a while since I've ascended anything higher than a 10-metre climbing wall. But with all this metal support, I'm confident enough to clip both carabiners to the steel safety cable, grab a rung and start to climb. I won't unclip for 5 hours.

A fixed anchoring system like the one at Nelson Rocks is known as a via ferrata – Italian for "iron road". It stays put while the climbers move on: no ropes to lug, no specialised gear to buy, no esoteric techniques to learn. These networks of ladders, cables and bridges were developed in the Dolomites during World War I, when they were used to move supplies and infantry through otherwise impassable terrain. After the war, mountaineers took over the routes and today, hundreds of via ferratas enable even raw beginners to access dramatic ridges and peaks in the Alps and Pyrenees.

At the Nelson Rocks Outdoor Centre, the 530 metres of 20-mm aircraft-grade stainless-steel cable (tensile strength: 5 360 kilograms), the 115 stainless-steel rungs and the 145 iron bolt hangers that went into building the via ferrata open one of the most unusual geologic formations in the region to exploration. Parallel fins of exposed Tuscarora quartzite rise high above the North Fork Valley like the bony plates on the back of a stegosaurus. Just 70 metres separates those fins, and in an inspired feat of amateur engineering, the via ferrata's builders link them with the route's most spectacular feature – a suspension bridge spanning the distance.

The route begins near the southern end of the west fin. Soon trees that towered above me at the base appear below as nubs in a green shag carpet. Near the top of the fin, which has narrowed to less than 2 metres, I enter a cleft in the rock, take a few steps and emerge in a portal with a spectacular view on the other side of the cliff – the east fin, rearing up out of the hardwood forest, and below, the spindly sus-



The team of climbers that built the Nelson Rocks via ferrata used Epcon A7 (left), an anchoring adhesive, to secure the 450 mm eyebolts (right, centre) that hold up the route's 70-metre suspension bridge. Drilling the hole for each eyebolt destroyed three carbide-tipped masonry bits.



Every 2 metres, climbers must unclip their carabiners (left) to move past the bolts securing the safety cable to the rock. Repositioning the 'biners one at a time ensures a constant connection to the cable. Via ferrata builder Doug Downs (above) holds an extra-wide rung. All rungs have a welded rivulet on the top side for added grip.

pension bridge that spans the gap.

The bridge is composed of wire handrails, an overhead safety cable and 50 x 100 mm beams 40 cm apart. From the portal I step off a rung, scramble along a ledge and then climb on to the bridge. It's like walking on a ladder laid flat – if that ladder were swaying in the wind 50 metres above the ground, bucking with each step.

Not everyone who attempts the via ferrata has the nerve to walk these planks, so an escape route just before the bridge leads to a hiking trail back to the base. Although the bridge is scary fun, the truth is that in building it, as with every aspect of the route, overkill ruled.

Stu Hammett, a lanky 53-year-old who speaks in a clipped cadence typical of southern Maryland, bought Nelson Rocks in 1997, just three years after a 13-metre climbing fall left him partially paralysed. But he was determined to climb again and to own land in the North Fork Valley, which he had come to love on climbing trips. With the help of special braces, he got back into the sport. A story in the local paper alerted him to the sale of the Nelson Rocks property, making the other dream possible.

An initial stab at opening the crag to climbers on a fee basis failed to cover costs. Then in 2001, Hammett read an article about a via ferrata that had just opened at Torrent Falls in Kentucky. "I knew right away that's what I'd build," Hammett says. "I got a quote from a French via ferrata builder and I said, 'There's no way I'm paying that price.' This is West Virginia, where we know how to do things ourselves."

Hammett hired seven self-described "dirtbag" climbers from up the road at Seneca Rocks to do the build, which began in February 2002. "I wanted something that would still be there when the rock wore away to dust, but it was all built by seat-of-the-pants engineering," Hammett says. They planned the via ferrata around established climbing routes and to take advantage of the formation's features. Working from the ground up, the builders drilled and glued in 115 rungs that can each support an estimated 4 000 kg.

To build the bridge, a team on top of the west fin dropped a static line and a 6-mm cord, which a second team hauled across the gap and to the top of the east fin. Once the

static line was taut, the east fin crew pulled the cord across as the west fin crew attached carabiners to link the line and the cord at 5-metre intervals, creating a trolley system. When the carabiners were attached, the west fin crew hauled the trolley back and clipped in a 20-mm galvanised steel cable, which the crew on the east fin pulled across the gap. "The cables were so heavy, they would've sagged," says Doug Downs, who helped build the route. "We didn't have the tools or the manpower to pull a big sag out of the cable."

Once that cable was secure, the process was repeated until all the cables were in place. The carabiners were unclipped and the crew rode across on pulleys to complete the bridge.

The bridge load is carried by eyebolts anchored with acrylic adhesive in holes 450 mm deep. It took two climbers on rappel to bore the



Doubling up on protection, Nancy Tilton (left) has clipped one carabiner above an eyebolt. She reaches to unclip a second carabiner and move it past the obstruction to continue her ascent.

The wooden slats of the 70-metre suspension bridge that links the east and the west fins of Nelson Rocks are widely spaced to allow wind to blow through, which keeps the structure from swaying excessively.

holes – one to wield a hammer drill and the other to press against the driller's back, gaining leverage by stuffing climbing cams into cracks and pulling hard on the attached ropes. There are 10 anchor holes; each required 90 minutes to drill. "It was a three-dimensional puzzle to put the anchors in the right place so that when the cables were tensioned, they were in the proper relationship," Hammett says. "We'd be up late drinking beer and trying to solve the next day's problems. There were arguments, some sore feelings, but it was one of the most exciting times of my life."

Mainstream climbers and managers of public land agencies are uneasy about marring rock with anything man-made (see "Locals love it... and hate it"). The rise of sport climbing (which uses permanent anchor bolts) in the late 1980s sparked controversy among traditional climbers. The conflict eventually faded. Still, says Brady Robinson of the American climber advocacy group Access Fund, glueing rungs and bolting cable into rock with the intent of making money is "shocking to plenty of climbers. But via ferratas are not inherently bad. You just don't want one in pristine wilderness or untracked forest".

By locating the outdoor centre on private land, Hammett escaped opposition. But the via ferrata still raises questions, even with Downs. "I've always battled with whether the via fit in my ethical boundary," he says. "Are we allowing people who shouldn't be up there to be up

there, or are we furthering conservation by bringing people somewhere they wouldn't be able to go, so they can see it and support its protection?"

Whether I could have scaled the crest of the east fin without the metal rungs is questionable. The headwall guarding it is intimidating: 20 metres high and overhanging. Climbers are forced to lean back slightly, which tires the arms. As I climb, I pause to watch as the cloud deck that shadowed us all day breaks apart and sunlight turns dull-coloured rock to gold.

I had intended to stand, arms outstretched, when I reached the apex. But the perspective here is dizzying. The block appears to be suspended in midair, and though I'm still safely clipped to the via ferrata, I have an overpowering sensation of being airborne – and a case of vertigo. The best I can manage is a surfer's crouch. So I move my carabiners past the bolts one at a time and head for solid ground. Click, clack. Click, clack.

Locals love it... and hate it

South Africans haven't had much exposure to the via ferrata. But even that limited exposure has been sufficient to ignite enthusiasm – and a row.

The Mountain Club of South Africa has joined the chorus of outrage over the potential environmental impact of an apparently unauthorised via ferrata route on the uKhahlamba Drakensberg Park World Heritage Site's Beacon Butte.

Mountain Club president Dave Jones says that his organisation actively promotes low-impact activities and protection and conservation of mountain wilderness areas. Internal investigations into possible Club members' involvement will follow.

Ezemvelo KZN Wildlife, which controls the park, has threatened legal action against those responsible. Besides, even though this is not a proclaimed wilderness, a via ferrata is simply not in line with plans for

the area, Ezemvelo says. But on the other side of the country it's a different picture: the via ferrata on Shelter Rock to the summit of the Magaliesberg has drawn enthusiastic reviews since its completion in 2009. The route is one of a range of activities offered by the operators, in fact, from abseiling to hikes.

According to Shelter Rock, via ferrata has become the fastest-growing outdoor activity in Europe. There are more than 300 of the routes worldwide as far afield as the USA, New Zealand, England and Malaysia.

It took four years (including an environmental impact assessment process) to obtain the required permissions for Shelter Rock, as the route is constructed in the Magaliesberg Natural Protected Area. The route itself is named after engineer

and mountaineer Sarel van Rensburg, who – along with his sons – laid out the stairway's final route. Similar to European designs, it complies with EU and SABS standards.

Climbers on the Shelter Rock via ferrata use an abseiling harness and cowtails fitted with an industrial shock absorber. The cowtails are attached to an 8 mm galvanised steel cable fixed to the cliff face every 2 metres. The steps themselves are designed to support an individual weight in excess of 500 kg.

Anyone in good health and fit enough to handle trail hiking would be right at home, the operators say. However, children shorter than 1,3 metres and aged under 13 are discouraged. Apart from the supplied equipment, climbers need nothing more elaborate than loose-fitting clothing and good shoes such as tennis shoes or light hiking boots. Allow at least 6 to 7 hours for the via ferrata and double pitch abseil, or about 2 to 3 hours less if hiking back down the marked trail.

PM

The via ferrata on Shelter Rock to the summit of the Magaliesberg has drawn enthusiastic reviews.



Glow, man GLOW

Electroluminescence is shedding a whole new light on everything from displays to safety gear

IMAGINE A LIGHT SOURCE thin enough to wear on a T-shirt or adorn a magazine cover, efficient enough to run on battery power and light a room, yet rugged enough to do duty as a billboard covering an entire building.

These are just a few of the fast-multiplying applications in the exciting world of lighting display that is being opened up by electroluminescent technology. You've probably seen it, without realising it. You know those lighting effects in the movie *Tron* that you thought were computer-generated? That was actually EL.

The technology is not new: it was being mooted for US aircraft instruments in the 1930s. However, advances – specifically, in materials suitable for thin film displays – have boosted development of the concept. So much so, that a local concern has convinced itself that EL is the next big thing and has made the switch from importing EL displays to becoming first in Africa to manufacture them.

"Essentially, we print micro-encapsulated phosphors (see "Inside EL") to produce a variety of effects at a huge efficiency gain compared with conventional displays such as neon," says Stephen Schutte, executive director of Cape Town-based Lumo Technologies. "The display operates at very low power – half that of traditional lighting. A typical setup uses the mains 220 V supply with a 12 V inverter."

Lumo makes two types of display:

- A white backlit panel like a light-box, with light shining through a translucent overlay. Light intensity can be varied according to the amount of phosphors used.
- An animated electroluminescent panel.

It's the second method that has advertising and marketing specialists all agog.

Because of the thinness of the material used in producing the display, it can be bent and shaped (anything short of an actual fold). It can be dropped into a table top, curved around a bottle, or moulded around a car's bodywork.

A printed circuit board and an appro-

Lumo media's Stephen Schutte gets to grips with lighting that can be bent, shaped – and printed.

priate power source – say, miniature disc batteries, perhaps even solar – add to EL's versatility. "Because the display is a moving as opposed to a static source, it's been calculated that awareness is increased more than six-fold," says Schutte.

The applications are wide-ranging. "We can light up DVD covers and high-visibility clothing. We have done a magazine cover."

It can be activated by sound, touch, even proximity.

As with all new technology, there's a distinct slowness to embrace EL. "To get the market to understand that there are no bulbs here is the hardest thing," says Schutte. "Having said that, though, I have not been in a presentation where the client has not gone 'wow'."

Inside **EL**

Some fields are receptive, though. "We have had good response from the advertising world, especially the drinks business. They are aware of the possibilities."

One of his company's landmark (in more ways than one) installations has been a huge billboard that covers the entire frontage of a building in Cape Town's nightlife artery, Long Street. To the uneducated eye, the finished product looks like a conventional animated neon display showing beer being poured into a glass.

"The question is, what would you normally use to accomplish this?" Schutte asks. The usual options are digital TV, neon and LED. "In this outdoor application TV is a non-starter; neon costs 40 to 50 per cent more; and LED is hellishly expensive." In the end, it cost about R1,5 million to achieve the desired effect – and you couldn't do the same thing with alternatives unless you had deep pockets, he says.

But there are many, many more applications. And more become apparent all the time. "We have started to print for the safety industry. We can do lanyards, harnesses, rope – we can produce a rope that lights for eight hours," Schutte explains.

They are moving into the realm of vehicles, working with the likes of vehicle-branding company Graffiti, which does upwards of 100 promotional brandings of vehicles a month.

In-store, instead of the expense and complexity of running mains power down the aisles for their displays, supermarkets could use self-contained battery-powered units. "We can incorporate a sensor unit to detect a customer in close proximity. This could lend a kind of 'interactivity' to the display, with possibly a touchscreen element as well that activates the lighting only when touched.

"This is opening up huge possibilities."

EL needn't be restricted to the world of marketing and commerce, either. It surely won't be long before we're able to simply touch a blank wall at home and see it spring into glowing life with gentle mood lighting that can be static or animated, according to our wishes. **PM**

Unlike incandescent lighting – which essentially uses the principle of heating materials until they glow – electroluminescence relies on an electronic reaction that causes certain substances to emit light. These substances are typically found in the form of a semiconductor and composed of rare earth compounds or transition metals.

In use, a strong electric field excites and accelerates the chosen material's electrons. These electrons interact with semiconductor "holes" and release their energy as light.

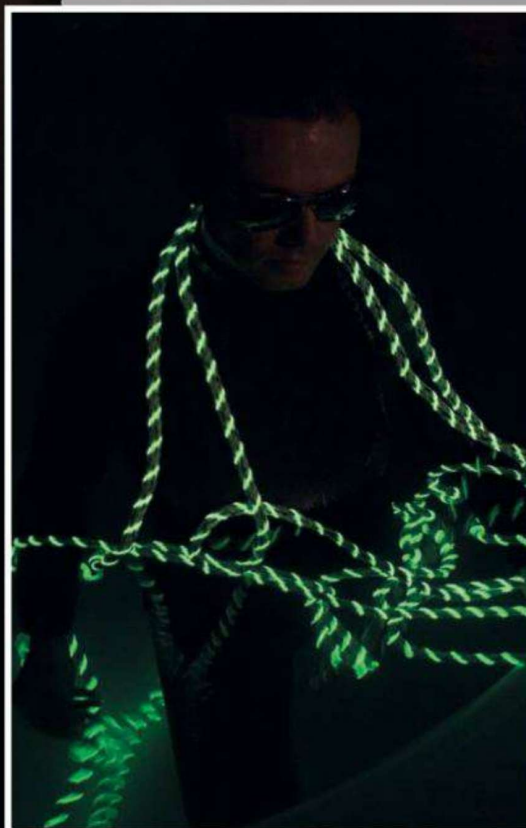
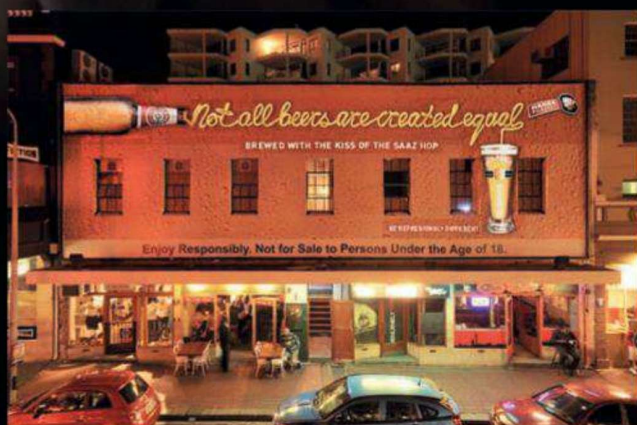
One of the more common combinations used to create the kind of thin film used in the lighting applications shown here is zinc-sulphur-manganese (ZnS:Mn). The raw materials used in the local process cost nearly R1 million a kilogram and are sourced from China, which dominates world markets.

"Without divulging too much, we mix phosphors with chemicals and print a series of layers on an energy-conductive film," says Lumo's Stephen Schutte. "We then capture that with a laminator."

Naturally, nothing is forever. Typical lifespan is about two years, after which time the phosphors degrade and light output drops.

Right: Powered illuminated strands can be woven through rope to provide visibility for rescue workers and riggers.

Below: Electroluminescent tech was used to create this billboard with less complexity and hassle than alternative methods such as neon.





Main picture: A computer-generated image of the University of Johannesburg's soon to be completed *Ilanga I* solar-powered vehicle. Bottom strip, left to right: The *BAR 1*, the hybrid vehicle that inspired the creation of UJ's Alternative Energy Vehicle Project; Kegan Smith poses with their hydrogen-powered vehicle; Side profile of *Ilanga I*; Line drawings of *Ilanga II*, UJ's second-generation solar vehicle.



Taking the GREEN ROUTE

Budding engineers prepare for the 2012 South African Solar Challenge

> BY SEAN WOODS

Oil lubricates the wheels that keep our modern world running.

At some stage, though, our dependency on this unsustainable fuel source is going to have to come to an end. Fully aware of the transportation challenges that lie ahead, a multi-disciplinary team of students from the University of Johannesburg is tackling the issue head on. Their objective: to come up with a real-world solution.

But closer to the here and now, these pragmatic boffins-in-the-making have set their sights on a more immediate goal. They intend showcasing their research to date by entering three alternative energy vehicles – one powered by the Sun, one running on hydrogen and the other incorporating a small turbine – into this year's South African Solar Challenge. They will be competing against other university teams from across the globe.

You only have to fill up your fuel tank on a regular basis and monitor your depleting bank balance to realise how increasing energy costs are coming into conflict with economic growth. It's a given that non-renewable fossil fuels are going to become more expensive over time. So, too, is the reality that petroleum currently provides about 40 per cent of the world's energy needs, and that some expect global energy consumption to grow threefold over the next 25 years. Then there's that inconvenient truth – global warming – exacerbated by the burning of fossil fuels.

Clearly, something constructive has to be done. The sooner some bright spark

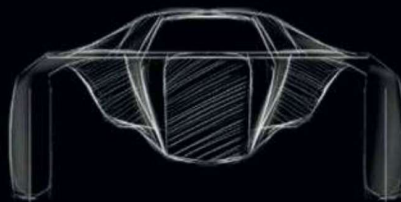
comes up with a viable solution, the better. With this in mind, the University of Johannesburg sprang into action. UJ encourages its students to think energy innovation, sustainable engineering design and manufacturing, and environmental awareness.

What better way to promote this strategy than the biennial South African Solar Challenge?

Masters student Kegan Smith, who heads UJ's alternative energy vehicle project, explains: "We've found that, if you provide people with a challenge, they rise to the occasion. The race is a great platform for exposing our students to real-world issues and deadlines while working on their studies. And, as tackling real-world issues requires a holistic approach, we have pulled our mechanical, electrical and electronic engineering, industrial design, IT and marketing departments into the project."

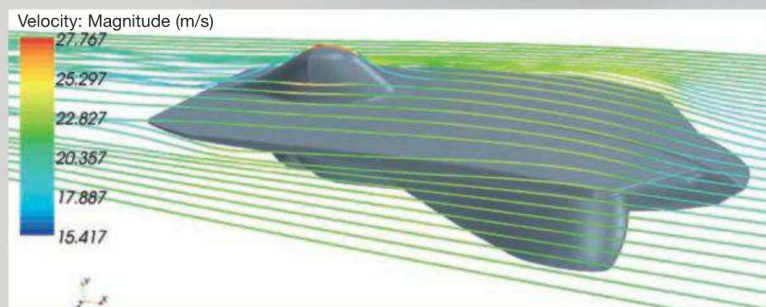
Students from these various disciplines have come together to design three vehicles, all of which are currently under construction. Each incorporates a battery bank and an alternative energy source; one uses solar panels, another is powered by a turbine generator, and the third incorporates a hydrogen fuel cell.

To ensure continuity, the project runs on an overlapping three-year cycle. Each team of students participates in the project for the full three years, from undergraduate to postgraduate level – thus encouraging knowledge transfer and the peer mentoring process. Each





Above: An exploded view of the *Ilanga I*.
Below left: A CAD illustration displays *Ilanga I*'s aerodynamic design.



vehicle is then tested in a solar challenge event, and then modified and refined by the next generation of students.

How it all began

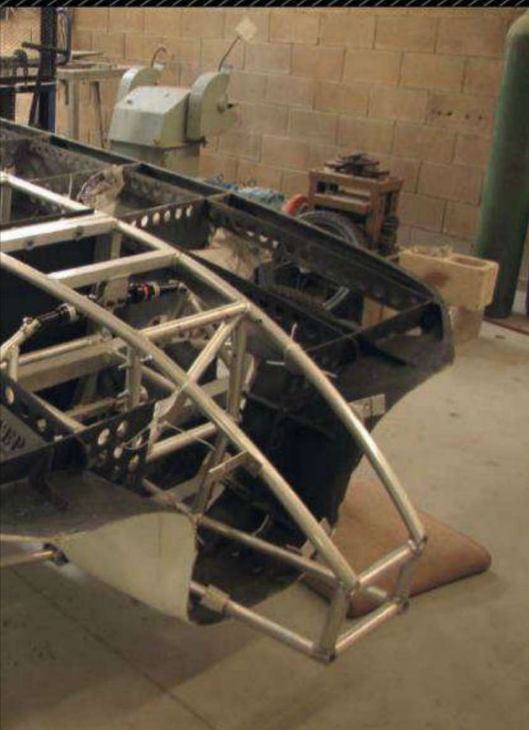
When UJ started the development of its first hybrid vehicle – the *BAR-1* – its sole intended purpose was as a technology demonstrator for masters students. The 2010 Solar Challenge was a tantalising carrot, five months away. But no one actually expected it to be completed in time. “Our lecturers were convinced we wouldn’t succeed, but they didn’t tell us it was impossible – they’re like that,” laughs Smith.

To everyone’s surprise, they completed the *BAR-1* on time. What’s more, they won the Adventure class and came in at second place overall.

“It incorporated much more than you’d find in a normal car,” says Smith. “Its robotic system, which I like to call ‘the next step to cruise control’, used lasers and actuators on the steering wheel and pedals to faithfully follow a car driving in front of it. Understandably, we didn’t use it on the race for safety reasons – anyway, it was a work in progress.”

To get it moving, Smith and his fellow students combined a Yamaha R6 motorcycle engine, hydrogen fuel cell, batteries and an electric motor to create one multiple-input hybrid powerplant. “Because of its parallel configuration, it could be powered by both the R6 and electric motors, or just electric regeneration, depending

South African Solar Challenge



on how we chose to run at the time.”

Needless to say, the BAR-1's success generated huge excitement on campus, and the powers-that-be quickly realised they had a winning concept on their hands. Then and there, UJ's Alternative Energy Vehicle Project was born.

Bring on the Sun

On the solar front, two vehicles are in the works; *Ilanga I* (Sun in isiZulu), which is almost complete and ready to pass on to



Centre: *Ilanga I* nears completion in one of UJ's engineering workshops. **Left:** Students work on a scale model of the *Ilanga I* to verify their computer-generated design.

the next generation of undergraduates – and the decidedly more sophisticated *Ilanga II* (which they expect to complete in time for the next SASC race in 2014).

At the heart of *Ilanga I* is an aluminium space-frame chassis featuring pushrod double wishbone front suspension, with a swing arm taking care of the rear. Lightweight marine ply ribs and stringers support its outer aerodynamic glass fibre shell. The terrestrial solar cells – they collectively cover an area of 6 m² – are arranged into five arrays. Each array incorporates a point tracking system to ensure maximum cell efficiency. Then, just in case the Sun doesn't shine, lithium batteries act as energy buffers.

Building *Ilanga I* proved to be a challenging experience. The solar project leader, Warren Hurter, explains: “As undergraduates last year, we had to learn how to build a chassis, fabricate our own circuit boards and work with composite materials from scratch. It didn't take us long to discover that coming up with a viable CAD design was the easiest part.”

Serious effort went into developing

software used to manage race strategy.

“It's all about power management. You start with full batteries and from then on you have to rely on the Sun,” says fellow team member Stephan Schoeman. “To make this happen we had to factor in variables that included weather, sunrise and sunset profiles, maximum gradient we could traverse and how to make up energy through regenerative braking. We also have to be able to calculate these values in real time without contacting the driver too much, as communication systems require lots of power.”

Work has just begun on their second-generation solar vehicle, *Ilanga II*. Once finished, this futuristic looking set of wheels will be one of the most expensive vehicles to be found on SA roads. Its 3 m² of space-grade Gallium Arsenide solar panels (the most efficient produced to date) cost about R3 million alone. Two super-efficient rear hub motors, power converters and controllers are collectively worth about R800 000. And let's not forget the fabrication of a carbon fibre monocoque chassis with gullwing doors, lithium battery pack, two custom-

Below left: Master's students Tony Corregedor (left) and Sven Holte collect data on their 6 kW turbine. **Right:** Apart from their different power-plants, the hydrogen- and turbine-powered vehicles are identical.



Top: Once complete, UJ's futuristic-looking *Ilanga II* solar vehicle will be one of the most expensive sets of wheels to be found on SA roads.

designed seats that form part of the safety structure and four carbon fibre motorcycle wheels.

The same, but different

Apart from their different powerplants, the hydrogen- and turbine-powered vehicles are identical. They use the same chassis, lithium battery packs and electrical systems to drive their permanent

magnet synchronous motors. The idea is that future students can some day replace components – for example, the battery management system – with their own, says Smith. “And, if they work better, we’ll incorporate them.”

The hydrogen-powered derivative incorporates an old 5 kW permanent exchange membrane (PEM) fuel cell, sourced from a cellular base station.

Hydrogen is a green fuel, but it’s also tricky to work with because of its volatility. Safety is critical: “We can’t afford to have any leaks whatsoever,” Smith says.

The hobby-grade turbine motor measures a mere 51 by 20 cm. But despite its small size, modest 6 kW output and high-revving nature (it idles at 70 000 r/min and goes up to 180 000), it is more than capable of spinning the generator that keeps the batteries charged.

Multi-fuel compatible (it currently burns paraffin, and there are plans to run it on methane), it boasts an operational efficiency of between 50 and 60 per cent, significantly better than a piston engine’s rather modest 32 per cent. Another plus: it has only three moving parts. “I honestly feel that, if more attention had been put into turbines instead of internal combustion engines, we’d be in a bet-

ter place right now,” says Smith.

When the teams competing in the 2012 Solar Challenge hit the road in September, UJ hopes to have all three of its designs on the start line. The *Ilanga I* will take part in the entry level solar class and the other two will compete in the Adventure class. Once complete, the *Ilanga II* will be entered into the prestigious Olympia category for the next event, taking place in 2014.

● Follow the progress of *Ilanga I* and *Ilanga II* on the University of Johannesburg’s solar car Web site www.ujssolar.co.za

Below: UJ’s hydrogen-powered vehicle utilises an old 5 kW fuel cell sourced from a cellular base station.



RACING FOR GLORY

The internationally recognised biennial South African Solar Challenge, which takes place this September, is a race not to be taken lightly. Designed to showcase solar technology and alternative energy breakthroughs, it’s a grueling, two-week affair. Competitors take on a circuitous 5 000 km route from Johannesburg, down to Cape Town, along the coast up to Richards Bay, and then back to the Gauteng start line.

“The designs entering the event are not toys; they are world-class competitive vehicles,” says Professor Johan Meyer, head of UJ’s Electrical Engineering School. “To give you some idea of what I mean, the Japanese team that beat us in 2010 used scrapped solar panels from the Hubble telescope. The cost of these vehicles can run into six zeros.”

PM

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FRIDAY MAY 18TH

Depart by luxury coach from Cape Town on the N1 through the Huguenot Tunnel via Worcester, the Hex River Valley, De Doorns and Touws River. This scenic drive takes you through mountains and winelands, and the Little Karoo. Next up is Matjiesfontein, which is best described as an "eccentric British Victorian time warp". Visit its transport museum and explore the village on foot or step aboard an old London double-decker bus for a (very brief) tour hosted by the energetic "Johnnie", who will entertain you later the same evening at the piano in the Lord Milner Hotel bar. You'll have dinner at the hotel, after which you're off to bed to dream of stars and extraterrestrials.

free to wander around Matjiesfontein and attend a fascinating lecture by an astronomer. (Feel free to ask difficult questions.)

After lunch, you'll board your coach to drive the 125 km to SALT, just outside Sutherland (in the Northern Cape). On arrival, we'll head straight to the observatory where, by special arrangement, you'll be taken on a three-hour afternoon tour, followed by stargazing until about 21h30. The return coach journey to Matjiesfontein should be quicker, we're told, because it's mostly downhill (!). You won't go hungry: we've arranged with the Lord Milner hotel to provide us with a packed dinner.

SUNDAY MAY 20TH

After a late breakfast at the hotel, the coach will depart for Cape Town, arriving about 13h00.

SATURDAY MAY 19TH

You'll enjoy a leisurely breakfast and lunch at the hotel, with the morning



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ONE LIFE



As this issue of *POPULAR MECHANICS* landed in subscribers' mailboxes, cinemas around the country were admitting audiences to one of the most extraordinary wildlife films ever produced, the visually spectacular **One Life**. Produced by BBC Earth Films and narrated by British actor Daniel Craig, this groundbreaking natural history documentary uses specially developed equipment and filming techniques to show animals at critical moments in their lives. In these pages, we introduce some of its leading characters...



For starters, *One Life* is unlike any other natural history documentary: it's intimate, high on drama and unashamedly emotional, with beautiful sequences that celebrate animal behaviour and ingenuity. As its creators tell it: "There are moments to make you gasp in awe, stare in wonder, laugh and cry."

In essence, the film celebrates the 3,8 billion-year-old story of life and survival on the third rock from the Sun – and not every chapter has a happy ending. You'll meet a frog no bigger than a human fingernail, watch a group of 40-ton humpback whales battling for supremacy and witness the

epic journey of a tiny poison arrow frog as it scales an impossibly tall tree to feed its tadpoles in the canopy.

Meanwhile, tucked away in her shadowy cave, an octopus mother makes the ultimate sacrifice: she's cared for her eggs over many weeks while she slowly starves. Her final glimpse is of her eggs hatching and hundreds of baby octopi swimming away. *C'est la vie*.

As the young grow, they confront the lifelong search for food, and the film shows different species that have come up with amazing solutions. Cheetahs have discovered the power of working as

a team; capuchin monkeys have worked out a series of steps – and included tools in their strategies – to gather and manipulate palm nuts. It's a fascinating and amazingly time-consuming skill: they spend up to eight years teaching their young the essential skills – stripping off the outer shell, drying the nut in the sun and using a boulder "hammer" carried from the river bed to crush the nut on an anvil-like rock.

Some creatures have a "killer" advantage in the hunt for food, among them the venomous Komodo dragon: one bite, and even a large water buffalo is destined

'For the filmmakers who spend their entire lives recording beautiful images of planet Earth's dwindling wildlife, I have only a sense of awe and a deep-rooted respect.'

– Daniel Craig

THE TEAM



George Fenton, *Composer*



Martha Holmes, *Director*



David Freeman, *Editor*



Daniel Craig, *Narrator*



Martin Pope, *Producer*



Michael Rose, *Producer*



Michael Gunton, *Director*



'We wanted to fly, run, swim, hunt and fight alongside our animal stars, letting the audience feel they are right there with the animals, experiencing the drama of their everyday lives.'



'... this may be one of the last opportunities we have left to show the world the complexities and wonders of their lives' – Michael Gunton and Martha Holmes



for a slow, painful death. In the hunt for food, some animals have developed near-miraculous means of escaping – such as running on water, like the quaintly named Jesus Christ lizard, or making their bodies impact-proof, like the pebble toad. And in the struggle for supremacy, snow monkeys have created societies that uncomfortably mirror aspects of human society, shunning outsiders from their luxurious hot springs.

Say Michael Gunton and Martha Holmes, who co-wrote and directed the film: "With the filming technology available to us now, we can get our cameras into places that give new and high impact perspectives on the drama of animal survival. We wanted to fly, run, swim, hunt and fight alongside our animal stars, letting the audience feel they are right there with the animals, experiencing the drama of their everyday lives."

It was the perfect time to make such a film, say the directors – partly because the breakthrough in HD technology with new high-speed and time-lapse photography meant they could film the most extreme and extraordinary animal behaviour for the first time in the most exquisite detail.

"It was also because as we enter the third millennium and understand more and more about the way animals live and survive, we're also understanding more and more clearly that many of the animals in this film are endangered and this may

be one of the last opportunities we have left to show the world the complexities and wonders of their lives."

More than four years in the making, and spanning habitats on every continent, *One Life* features a number of significant "firsts". In fact, almost every story features an animal filmed for the first time, a new behaviour or a new filming technique applied to a familiar animal. The breakthroughs included:

- The use of super-high speed cameras, revealing hitherto unseen aspects of the animals' behaviour. For example, this allowed them to film sailfish attacking a baitball. Sailfish swim so fast that it is virtually impossible to see how they catch fish; by slowing down the action 80 times, their technique is revealed.

- The development of a new piece of equipment dubbed the "yogicam", whereby the stabilised camera normally used for filming aerial shots is mounted on a counterbalanced arm in an off-road vehicle and used for tracking alongside animals. In this way, the crew were able to walk with elephants, and for the first time create the feeling that the audience was in amongst the herd.

- HD Macro cameras reveal intimate details that can't be seen with the naked eye, allowing the audience to be up close and personal with the animals as they fight for survival.

- Gems include brown tufted capuchin cracking palm nuts in super slow motion,

red foxes hunting Nubian ibex, gyro-stabilised aerial shots of lammergeyer and red-billed tropicbirds in flight, three cheetahs hunting co-operatively to bring down ostriches, tracking time-lapse of the Venus flytrap, Komodo dragons hunting buffalo, an elephant shrew running in super slow motion, pebble toads bouncing down a cliff to avoid tarantulas, Darwin's beetles fighting in the tree-tops, and the first complete sequence (including aerials, underwater and topside) of a humpback whale mating contest. **PM**



REACHING FOR THE SKIES

STORY: SEAN WOODS



Paul Potgieter Jr, Aerosud's Innovation Programme manager and head of the AHRLAC project, shows off the company's soon-to-be-completed prototype. When full production starts in 2013 this armed, multifaceted flier will become the first aircraft to be designed and manufactured in South Africa since the Roivaalk attack helicopter in the 1980s.

AHRLAC SPECIFICATIONS

Overall layout:

Pusher configuration; Uno structured forward view for sensors and internal high-velocity 20 mm cannon; flexible belly-mounted multi-mission sensor pod; high wing for good external view and rough field operation.

Maximum take-off weight: 3 800 kg

Service ceiling: 9 448 m

Length, wingspan, height:
10,5 m x 12 m x 4 m

Payload with full fuel: 800 kg+

Cockpit: Tandem seat two crew, sized for Martin Baker Mk 16 ejection seats; large vertical cockpit separation; multi-function IFR glass cockpit

Engine: 1 x Pratt & Whitney PT6A-66B 708 kW (flat-rated)



Homegrown multi-role flier will take on the world



FOR GOVERNMENTS WANTING to manage their domain, there's nothing quite like an all-seeing eye in the sky to get the job done – especially if it's equipped with some useful teeth. However, keeping an airborne watch on national assets, and then responding with appropriate force should the need arise, generally knocks a big dent in national coffers.

Enter AHRLAC (Advanced High-Performance Reconnaissance Light Aircraft), a home-grown solution to a global problem. Born from a collaboration between defence and aerospace company Paramount Group and aeronautical component manufacturer Aerosud, this locally developed flying machine – the prototype is still undergoing development at Aerosud's Innovation and Training Centre near Pretoria – has created quite a buzz in international aviation circles.

Here's why. For starters, it's extraordinarily versatile, with the ability to tackle anything from basic visual reconnaissance to disaster relief and emergency supply, advanced electronic surveillance roles (via interchangeable pods housed in its fuselage) and even light attack roles – all at a fraction of the cost of typical airborne platforms.

THE BIRTH OF AHRLAC

The rationale behind its development makes perfect sense. On the one hand, there's the cost factor. Thanks to the global financial crunch, even affluent Western governments are under pressure to cut defence spending. Faced with this reality, cash-strapped developing nations are facing serious challenges in tackling the effects of climate change, the increasing demand for peace-keeping and humanitarian relief missions, terrorism and other security issues.

Another consideration is the rising demand for Unmanned Aerial Vehicles (UAV). Although autonomous fliers have racked up great press from the conflicts in Afghanistan and Iraq (thanks largely to the absence of any serious aerial threats in these conflict zones), they by no means offer a complete solution. That's because, aside from being extremely complex and thus prohibitively expensive to operate, they also lack multi-role flexibility and situational awareness.

Ivor Ichikowitz, executive chairman of the Paramount Group, elaborates: "The reality is that the technology behind UAVs has been oversold, and that the AHRLAC provides a far more comprehensive solution. It has strong defensive capabilities, which means it can operate in hostile airspace; plus, it can carry out operations in domestic airspace because it's piloted.



Landing gear:
Retractable, optimised for semi- and unprepared sites

Max cruise speed: 503 km/h
Max range on internal fuel: 2 130 km

Take-off distance:
550 m with full payload

Special mission equipment: Conformal and interchangeable mission-specific pod accommodating combinations of: FLIRs, SAR radar, active and passive EW and ELINT/COMINT

External stores: 4-6 wing hard points that can accommodate external fuel tanks; rocket pods; beyond visual range air-to-air and air-to-ground missiles

"This makes it ideally suited to some of the long-term security issues facing the world – such as drug trafficking control, piracy, patrol of exclusive economic zones, protection of fisheries and rain forests, coast guard and border surveillance, and the monitoring of strategic installations. The cost-effectiveness of this aircraft means that more countries will be able to access the kind of operational capabilities once restricted to a handful of superpowers."

A third push for the AHRLAC's development was the fact that Aerosud – founded



in 1990 by the core design teams responsible for the development of the Rooivalk attack helicopter and Cheetah fighter jet – wanted to retain its design and developmental capabilities.

Explains Paul Potgieter Jr, Aerosud's Innovation Programme manager and head of the AHRLAC project: "Our primary function nowadays involves military upgrades as well as the manufacturing of parts and assemblies for Airbus, Boeing, BAE Systems, AgustaWestland helicopters and Spirit AeroSystems. However, we realised that everyone involved in our aerospace industry was approaching retirement age, and that if we didn't do something about it, we would lose all our local expertise."

Their solution? Draw as many grey-haired aviation boffins as possible into their fold – even if that meant seducing some of them out of retirement – and teaming them with a bunch of inexperienced but undoubtedly smart engineering graduates to ensure a seamless transfer of skills.

From this successful strategy was born Aerosud's Innovation and Training Centre. Dubbed "skunkworks" by insiders (the name is derived from America's *Lil' Abner*

comic strip, later adopted by the Lockheed aircraft company during WW2), it's here that the 35-strong engineering team, with its yawning generation gap, brainstorms ideas and comes up with innovative solutions.

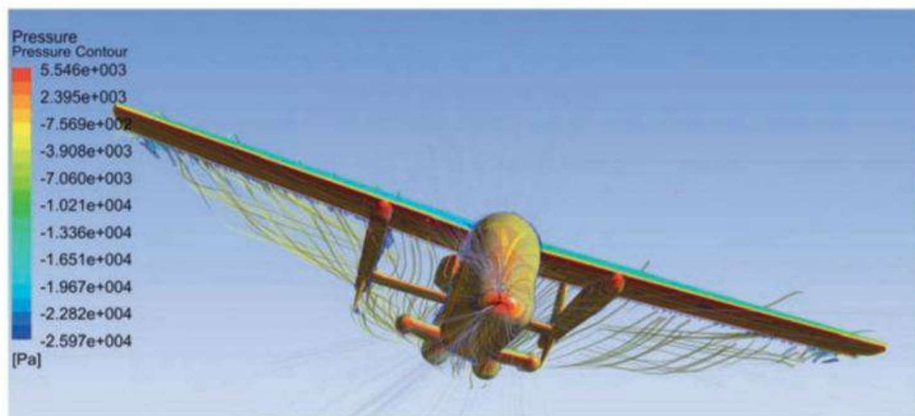
STARTING FROM SCRATCH

When Ichikowitz, Potgieter Jr and his father (Dr Paul Potgieter, Aerosud's MD) first started exchanging ideas for a multi-purpose light aircraft that could be fully integrated into the high-tech communication network of Paramount Group's land-based systems in 2008, the two companies already had a basic working relationship, but nothing was happening on the innovation front.

What they needed was a modular design that could be configured to suit various applications and roles. It had to be capable of rapid deployment and fast response times, able to land and operate from basic or semi-prepared airstrips with minimal

Eventually, the only designer willing to get onboard was Manie Warren, a veteran with formidable experience in drawing aircraft, and who'd worked on virtually every local aviation project since the 1970s. Next, they hired Estiaan Jacobsz, freshly graduated from Potchefstroom University and an enthusiastic pilot. Now the plan was starting to come together, and the initial design phase could get under way – albeit with an incredibly small team, and no budget whatsoever.

After spending a few months hunched over computers (not to mention a fair amount of begging, borrowing and stealing as the financial constraints kicked in), Potgieter received a surprise call from Ichikowitz, who announced that he'd be bringing a potential client to see them in one month's time, adding that they had "better be ready". Recalls Potgieter: "At the time, we had nothing ... just a bunch of pretty pictures on a PC!"



or no logistical support, and have short take-off and landing capabilities. Oh, and it had to be armed.

The initial plan was to modify a small production aircraft, but it soon became apparent that such a machine wouldn't handle the required payload, so the only solution was to design something from scratch. As challenging as this seemed at the time, it proved to be the least of their worries. "I couldn't find anyone to join me," recalls Potgieter. "Everyone I approached didn't believe it could be done here in South Africa."

Above: All components were designed along with engineers' right at the start of the CAD process. Top left: Paramount Group's executive chairman Ivor Ichikowitz, the driving force behind AHRLAC's development. Top middle: To verify Aerosud's manufacturing process, artisans hand-built one of the twin 3,6 metre-long tail booms on a table sans jig. Top right: A small model undergoing wind tunnel tests.

Potgieter's team, now comprising six people, went into overdrive to complete a mock-up model. Working around the clock – and for the last 36 hours, flat out without sleep – they managed to make the deadline. The rest, as they say, is history. Both Ichikowitz and the client were impressed, Aerosud got their financial backing, and the project could finally begin in earnest. Says Potgieter: "All of a sudden, engineers were knocking on our door; now I had the pick of the crop!"

GETTING DOWN TO BUSINESS

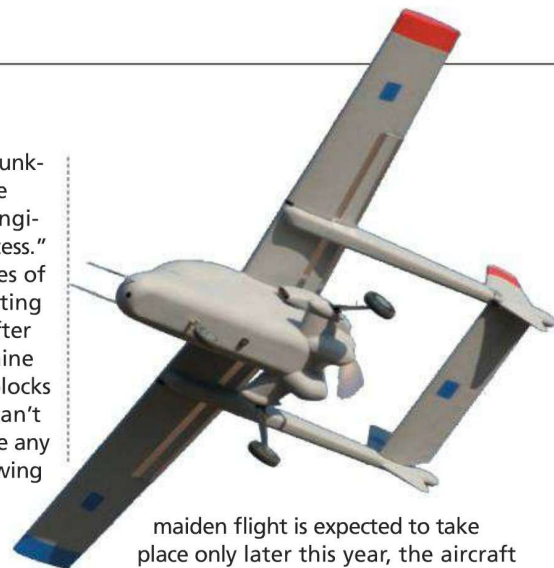
Realising how costly it was to develop a new aircraft from scratch using conventional methods, Aerosud opted for an entirely new approach. Potgieter explains: "When I sat down and did the costing, I discovered that you can expect to spend the same amount on jiggging as in development. There just wasn't enough money available for us to double the budget, so innovation had to happen – we had no other option."

Here's what typically happens with such a project: first, the aircraft is built entirely by hand. Next, a manufacturing engineer designs the specialist tooling and machinery, and develops the processes required to make production possible. That accomplished, a few aircraft are built to verify the full system.

According to Potgieter, Aerosud's skunkworks operates differently. "Here, we design components along with the engineer right at the start of the CAD process." They also bought two important pieces of machinery – a five-axis router for cutting sheet metal (both in flat form and after shaping) and a five-axis milling machine for carving components out of solid blocks of aircraft-grade aluminium. "If we can't use these two machines to manufacture any of our designs, we go back to the drawing board and start all over again until we can."

To verify their computer-to-component manufacturing process, Potgieter's team hand-built one of the twin 3,6 metre-long tail booms on a table – without a jig. "When we finished it, we found we were out by just 0,5 mm. And when a full load test was performed, it deflected 68 mm, just as predicted. This not only validated our new manufacturing methodology, but also the expertise of the artisans who had built it."

To date, Aerosud's quarter-scale AHRLAC radio-controlled model has conducted 100 successful test flights, proving that their design is aerodynamically sound. They are also working flat-out to complete a full-sized prototype. Although the AHRLAC's



maiden flight is expected to take place only later this year, the aircraft has already garnered serious international attention.

Says Potgieter: "We've right-sized it for the world market. At first, we were targeting only the developing nations, but now even First World markets are expressing strong interest."

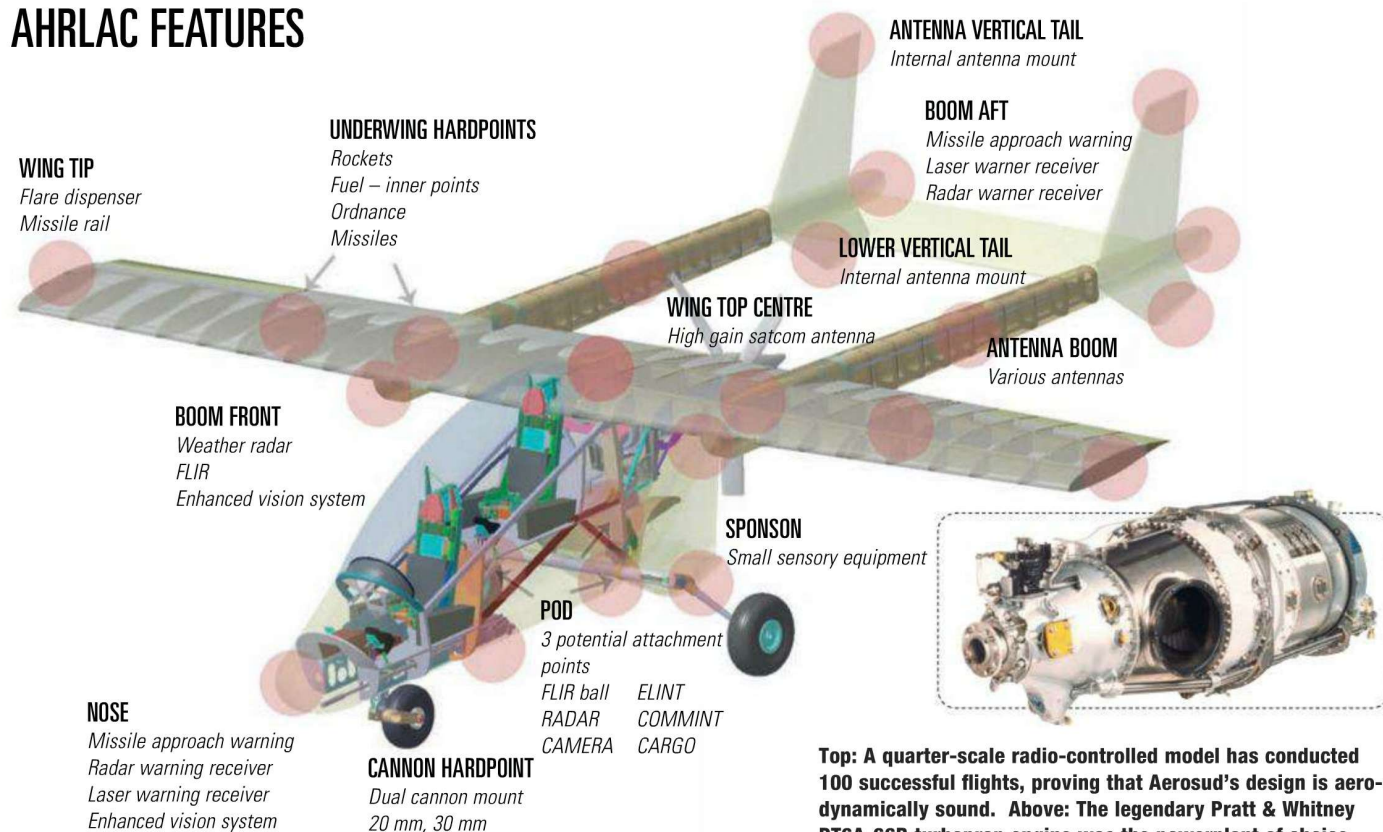
In basic form, the AHRLAC is expected to cost a modest R75,5 million (remember, it's all relative). However, if you'd like to add some extras – such as a sophisticated surveillance system, a high-velocity 20 mm cannon or a few rocket pods – you'll have to dig a little deeper.

Visit www.ahrlac.com for more information.

PM

'Everyone I approached didn't believe it could be done here in South Africa.'

AHRLAC FEATURES



Perpetual water tap

This is a project that will keep people guessing! Water flows from the tap, hour after hour, apparently being allowed to run to waste. Those with a wicked sense of humour will find it great fun to observe visitors' faces when they notice it. The perpetual stream of water is a very successful illusion, and you will find that most people are compelled to turn the tap off, and to berate you for wasting water.

> BY ALAN AND GILL BRIDGEWATER

You will need

Materials for a perpetual water tap 1 m high and 700 mm in diameter

- Plastic bucket (for the sump)
- Medium-size submersible pump
- Flexible armoured plastic pipe: long enough to protect the full length of the pump cable
- Hardcore: 1 bucketful
- Electricity circuit breaker
- Natural wooden post: treated with wood preserver, and with bark removed, 1 m long
- Tap: brass or copper wall-mounted tap (old or new)
- Copper water pipe: 1,2 m long, 15 mm in diameter
- Copper tap bracket: Bracket wall plate with screw thread to fit the tap, a compression joint to fit the pipe, with screw to fix it to the post
- Copper saddle clip: 15 mm with screws to fit
- Compression elbow: 2 copper compression corner joints to fit the pipe
- Slates or tiles (waste pieces)
- Plastic tube: 500 mm long and 15 mm in diameter (to link copper pipe to pump), with hose clips to fit
- Natural border log roll: 2 m long, 300 mm high
- Plastic sheet: a circle about 1 m in diameter
- Galvanised 6 mm wire mesh: 600 mm square (allows for cutting waste)
- Cobbles: 25 kg

Tools

- Wheelbarrow
- Spade
- Tape measure
- Log saw
- Pipe cutter: large enough to cut the copper pipe
- Screwdriver
- Adjustable spanner
- Bucket: for hardcore
- Club hammer
- Scissors
- Wire snips

WATER ON TAP

The perpetual water tap is an ingenious project: once the pump is running, the tap appears to have been left on. The quaint brass tap, with the understated wooden post and the log roll surrounding fence, suggest that the whole set-up is old. Visit car boot sales and flea markets to search out a tap that has character, and that can be wall mounted. Ours dated from the 1920s, and probably comes from an old bath boiler.

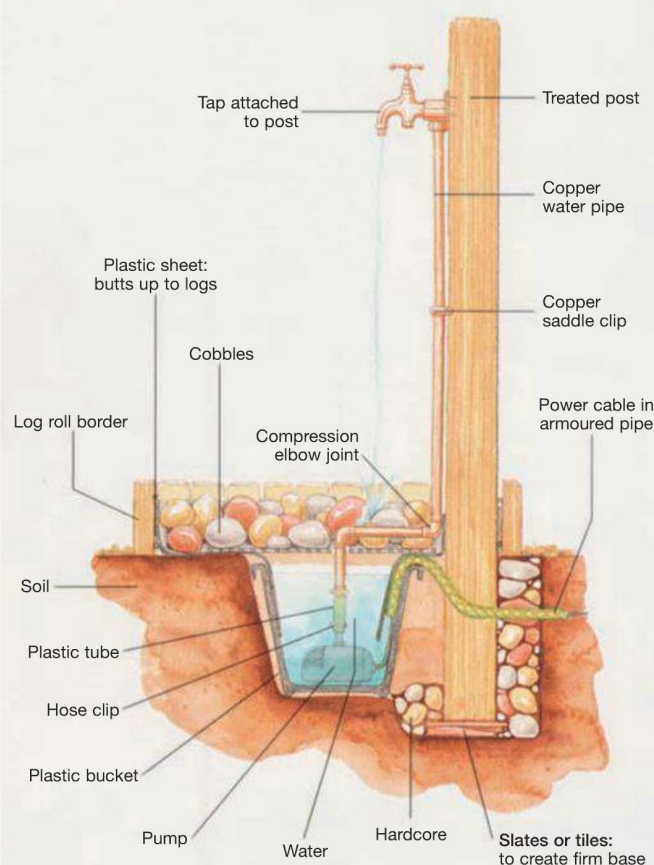
TIME

A weekend (eight hours for the copperwork plumbing and eight hours for digging the sump and setting up the pump).

SAFETY

Cut copper and clipped wire mesh are both difficult to hold, with lots of splinters of copper and sharp, jagged edges, so be sure to wear goggles and leather gloves.

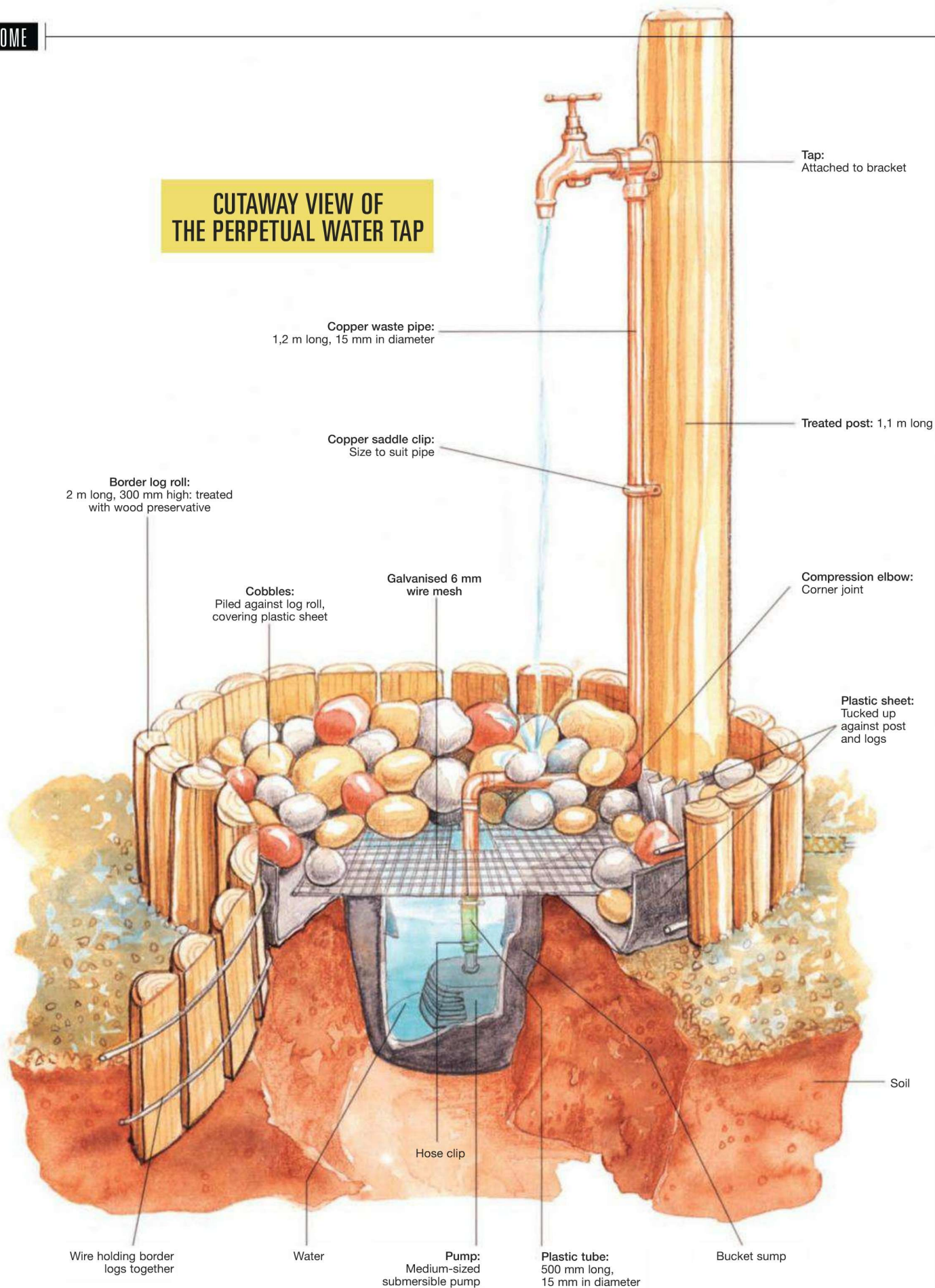
CROSS-SECTION OF THE PERPETUAL WATER TAP



Clean the tap with metal polish and remove the washer. Because the perpetual water tap is self-contained, with its own integral sump and pump, it can be sited just about anywhere in the garden. However, to consolidate the illusion of a functional tap, choose a spot where you might conceivably want a water supply – perhaps in the corner of an orchard, by the garden door, or in a courtyard.



CUTAWAY VIEW OF THE PERPETUAL WATER TAP



Step by step: Making the perpetual water tap

Spade:

Use a small spade for digging clay soil

Stones:

Make sure that you remove any sharp stones



- 1 Use the spade to dig a hole wide and deep enough to hold the plastic bucket. When the bucket is in place, the rim should be flush with the ground. The bucket must not be jammed in place – it should fit easily into the hole. Level the bucket with pieces of stone if necessary.

Pump:

Test the pump after every fitting stage

Cable protection:
Protect the cable with armoured pipe

Handle:
Leave the bucket handle attached until the last moment.



- 2 Clean the bucket and position the pump in it, fitting the cable with armoured pipe and an electricity circuit breaker. Fill the bucket with water. Switch on the power and check that the pump is working. (Pumps can be fickle – keep testing them during construction.)

Copper saddle clip:

Bridge over the copper water pipe and screw in place

Bark:

Scrape the bark off the post



- 3 Measure and cut the post to size with the log saw. Use the pipe cutter to cut the pipe lengths, join the pieces of pipe with the compression elbow joints (but do not fully tighten the joints), and fit the tap bracket and tap. Fix the pipe and tap bracket to the post using saddle clips and screws, and tighten the compression joints with the spanner.

Joints:

Avoid over-tightening the plumbing joints

Pipe position:
Ensure that the pipe is centralised in the bucket

Fixing the post:
Bang hardcore around the post until is firm and stable



- 4 Set the post in the ground, placing it on tiles to broaden the base of the post and prevent it from forcing itself into the ground. The inflow end of the copper pipe goes into the bucket. Put broken hardcore around the post and beat it down with the club hammer. Link the pump to the copper pipe by means of the plastic tube.



Surround the bucket sump with the border log roll, making an enclosed well. Cover the well with the plastic sheet, cutting a cross in the middle so it flaps into the bucket. Cover the plastic with the wire mesh. Trim the plastic (with the scissors) and the mesh (with the snips) so that they fit within the well.

5

Arranging the plastic:
Spread out the plastic and ease it up the side of the log roll



Outlet hole:
Cut a hole in the mesh for the pipe to slide through

HELPFUL HINT

If you want to have a larger tap and a greater flow of water, you will require a bigger apron of plastic sheet, so that the increased spray of water is directed back into the sump.

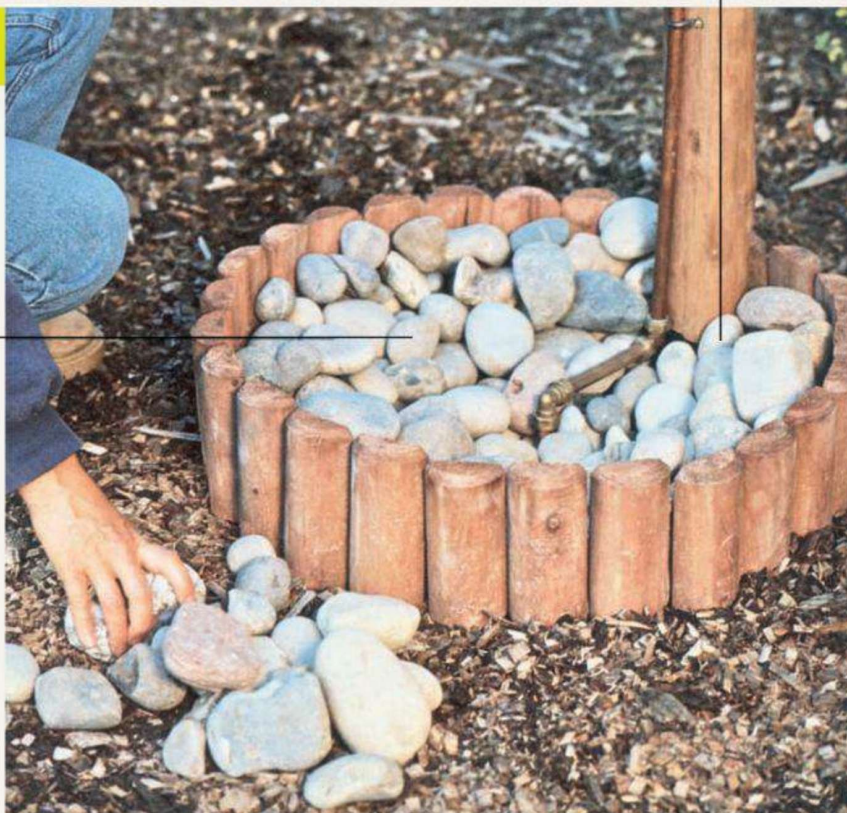
Post support:

The cobbles around the post give it extra support

Fill the well with cobbles, concealing the plastic and the mesh completely. Finally, fill the bucket with water, switch on the power, and turn on the tap.

6

Cobble covering:
Pile cobbles inside the log surround until the mesh is completely concealed



Reproduced from *Water Features for the Garden*, by Alan and Gill Bridgewater, Published by New Holland.

WIN

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DEWALT

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SMS: Dewalt, followed by the answer, your name and e-mail address to 32697 (R1,50 per SMS) or visit our Web site at www.popularmechanics.co.za. Competition closes 30 April 2012.

Rules: 1. Entry is open to anyone except employees (and their immediate families) of RamsayMedia, DeWALT and associated agencies. 2. Only one online entry per person. You may enter via SMS as many times as you like (SMS charged at R1,50). 3. Competition runs until 31 May 2012. 4. We will draw the winner(s) on 8 June 2012. 5. The prize is not redeemable for cash. 6. The judges' decision is final and no correspondence will be entered into. 7. Regrettably, only South African residents are eligible for prizes. 8. Prizes not claimed within 3 months will be forfeited.

A Into every life a little rain must fall, but it's best if it doesn't fall into your car. When weatherstripping – the rubber seals that keep water and air from infiltrating the cabin through the doors and the boot lid – starts going bad, that rain eventually ends up on your seats, floorboards, carpet and boot. Sometimes when weatherstripping fails, you'll find a slow leak that can cause

Weatherstripping: keeps the inside in and the outside out. When these rubber seals go bad, your car will leak heat and air conditioning, as well as face assault from wind and rain.

water accumulation – cars have been known to end up with a wading pool where passengers' feet should go. The good news is that identifying problem seals isn't very difficult and neither is replacing them, although it can be a bit expensive.

Finding a seal breakdown might take some detective work. Just because you find wet carpet in the rear passenger area doesn't mean the failure is in the rear passenger door – water has a funny way of sneaking around in a car. The wind noise you hear while driving is a good indication of the source of the leak; follow it to narrow your search. Inspect the seals around the door-frame and the perimeter of the door itself. Many times you'll find that the seals have cracked with age or that a hole has worn through from use. Sometimes the rubber will have lost its pliability and can no longer do its job. Check by squeezing it between your fingers; if it doesn't squish or spring back, it can't make a proper seal. If you're having a hard time pinpointing the source of a leak, run water from a hose to find it.

Once you've found the problems, you have several ways to address them. Really enthusiastic owners will see bad weatherstripping in one part of the car as a sign that all of it is failing and will replace all the stripping as preventive maintenance. Frugal owners will fix just the problem areas; that's fine, too. Cheapskates will break out the silicone sealant or duct tape; this is not recommended.

Weatherstripping comes in two varieties: factory-replacement and generic. Generic can be a little sketchy and is best suited for a very old car or junker you won't be keeping long. If you want a proper fix, and judging by your pride in ownership, you do, factory-style replacement is the only way to go. Cross-shop your VW dealer against aftermarket retailers to find replacement parts you're comfortable with. Most of the time aftermarket replacements are just fine, but it's up to you. Before you start ripping stuff out of the car, though, compare new pieces with what you're replacing to make sure they're all the same size, with appropriate cross sections, holes and joints.

If there are any screws holding the old pieces in place, take those out first and set them aside for reuse later.

A LEAKY SITUATION

I have a great 1984 Volkswagen GTI that I love dearly, but lately I've been noticing a lot of wind noise on the highway and water dripping down the inside of my windows when it rains. I suspect the weatherstripping is going bad. How can I tell, and if that's the problem, how do I replace it?



Peel away the stripping; be sure to remove the adhesive layer holding it on. You may need to use an adhesive remover to get it all. Next, wipe the weatherstripping channel and the new seals with a gentle cleanser and towel them dry; they may still retain a bit of mould-release agent. Apply a very thin bead of weatherstripping adhesive (available at automotive parts stores) to the channel and install the seal lightly at first. Be sure everything is properly aligned, then press the stripping firmly into place, ensuring good contact with the adhesive. Replace any screws and allow the adhesive to dry as directed. This should solve your whistles and wetness and prevent any undue carpet sogginess in the future.

WARNING WOES

Q Every year around the beginning of winter, the Low Tyre light shows up on my Toyota's dash. I add air and bring the tyres up to the recommended pressure, but the light remains on. Oddly, it shuts off in warmer weather. Can you tell me how to reset it?

A With all tyre-pressure monitoring systems, if your tyres are correctly inflated the warning light should turn off on its own once the pressures are within spec. Before we go down the diagnostics road, we should probably eliminate the pressure gauge as the source of the problem. When temperatures turn colder, the volume of the air in the tyres shrinks. It's fairly normal to have to fill your tyres with additional air in the autumn or the winter. The thing is, if the pressure gauge is reading wrong it could be telling you the tyre is full when it isn't. It's probably worth a few bucks to get a new, high-quality, handheld gauge to make sure you really are filling the tyres to the recommended pressure before you start blaming the car.

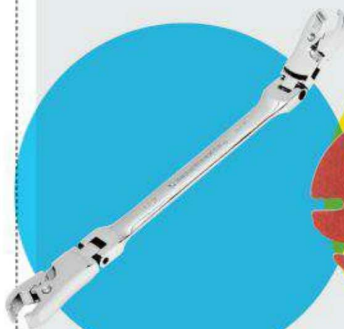
Now that you know your tyres are correctly inflated, let's consider the other options. I've seen diagnostic systems stubbornly hold on to warning signals for no apparent reason. If you're lucky enough to have access to an OBD-II scanner, plug it into your OBD-II port in the driver-side footwell, then turn the key to the "on" position without starting the car. The machine will scan the car's codes; you should get one in the format of C07XX, which is related to a tyre-pressure-sensor fault. The scanner will give you the option to clear that code, which you should do. Then unplug the scanner, start the car and see if the light stays out. If it doesn't, one of the in-wheel sensors



TOOLBOX UPGRADES

TAKING THE PAIN AWAY

IT'S BAD ENOUGH DOING FUSSY OR HARD JOBS LYING ON YOUR BACK UNDER A CAR, BUT HAVING TO USE THE SAME UNWIELDY TOOLS YOUR DAD DID ONLY ADDS INSULT TO INJURY. HERE ARE THREE NEW EASY-TO-USE AND INEXPENSIVE SPECIALTY TOOLS TO MAKE PAINFUL JOBS MORE PLEASANT.



GearWrench

replaces the awkward flare-nut wrench for removing brake-line fittings (a slow and tedious task) with a tool featuring an ingenious ratcheting mechanism. (gearwrench.com)



Jooltool

Coolview see-through grinding and sanding wheels let you see the work surface all the way to the edge of the disc. High-quality 3M pads quick-mount to the wheel for easy replacement. (jooltool.com)



NES ThreadMate

is a universal thread cutter that makes fixing damaged bolts or rodends easy, taking the place of a whole boxful of finicky dies. (angloamerican tools.com)

may be malfunctioning. In this case, Toyota technicians will have to run a system diagnostic.

HARDWARE-STORE PARTS

Q I changed both the crankcase and the transmission oil in my 2001 Harley Road King the other day, which requires new O-rings on the oil-pan plugs. After buying them from the bike shop, it dawned on me that I might find cheaper replacements at my local hardware store. Sure enough, I found a 10-pack of what looks like exactly the same O-rings for much less. Will these withstand the heat generated from the engine?

A This is always an interesting dilemma. The thrifty among us peer over to the hardware aisle and see visually similar components at a fraction of the price of factory parts and wonder if they'll work. The issue in using household bits in motorcycles or cars isn't just whether they'll hold up to heat, but if they'll endure repeated thermal cycling, chemical exposure, compression and vibration in the way factory seals will. In all likelihood, the seals you spotted at the hardware store match the physical dimensions, but not the chemical composition. Using those plumbing seals might work on your Road King for a while, but over time you

may find an oily puddle under your bike, making you fit every Harley stereotype other bikers love to poke fun at.

ASSAULT WITH BATTERY

Q I have a 2007 BMW 525i that has about 105 000 km on it. It won't be long until I need to replace the battery. The dealer says that I should let him do it so he can reset the computer's charging circuit. He says if I replace it myself, the battery won't charge properly. Can I do this myself and somehow reset the computer?

A Your BMW, being "ze ultimate driving machine", actually tracks the battery's charge and discharge cycles and predicts its usable life. When the car's computer decides that a battery is up for replacement, the driver gets a warning that can't be cleared unless a new battery is installed and the car is hooked up to a service tester at the BMW dealer. This registration process records the car's age and mileage and resets the battery-life monitor. This isn't to say you can't simply swop the battery yourself – you absolutely can. However, you need to know that the warning light will never go away and that you'll be responsible for tracking when to replace the battery. **PM**

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NEWS BLOGS MULTIMEDIA SCIENCE TECH WHEELS DIY MAG GADGETS WIN SUBSCRIBE

VIDEOS



ANGRY BIRDS SPACE

For nearly three years, millions of gamers have used physics in the battle between birds and pigs in the video game Angry Birds. In co-operation with Nasa, Rovio Entertainment has announced its newest game, Angry Birds Space, which is available on iOS, Android, Mac and PC.

Aboard the International Space Station, Flight Engineer Don Pettit of Nasa created this video using Angry Birds Space to explain how physics works in space, including demonstrating trajectories in microgravity by catapulting an Angry Bird through the space station...



THE AVENGERS

Here's the latest and most revealing (to date) trailer of Marvel Studios' upcoming release, *The Avengers*...

This hotly awaited action/adventure epic, featuring some of the biggest actors and most famous comic-book characters in history, will hit South African cinemas on Thursday, 26 April 2012. Prepare yourself for excitement, action and spectacular special effects.

Visit www.popularmechanics.co.za to enter to win awesome *The Avengers* goodies and to read an article about what went on behind the scenes of *The Avengers* (search keyword: The Avengers).



Check out both videos using the QR codes provided (if you don't own a tablet or smartphone, you can watch the videos on www.popularmechanics.co.za).



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YOUR TWEETS

@La_Fee_Verte_3: The Mayan calendar didn't account for leap years so technically the world should have ended 7 months ago #doomsday @popmechsa

@johannesbertus: The March edition of Popular Mechanics is brilliant. Best thing in South African magazine publishing at the moment. @popmechsa

@Magazinescoza: The fab guys & girls at @popmechsa are giving away a #Ford Focus Trend 1.6. Subscribe & you could be the proud owner.

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iHome iA100 iPad Radio/Dock



The iA100 is the flagship bedside solution from iHome. With iPad charging and docking, Bluetooth 2.1 + EDR, iHome app-enhancement, and Bongiovi Acoustics DPS, the iA100 is today's ultimate docking FM clock-radio.

Owl Electricity monitor




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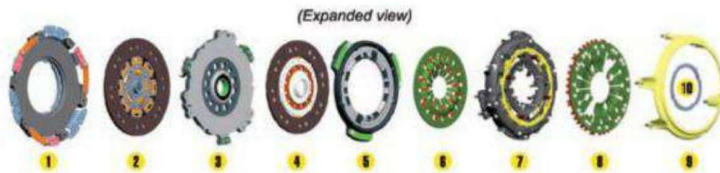
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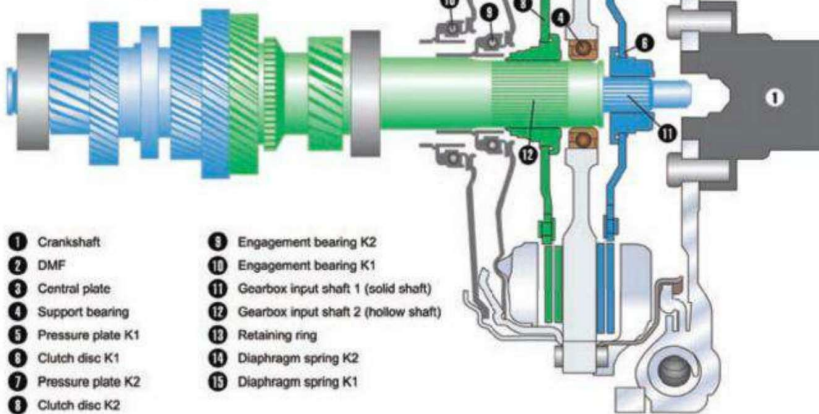
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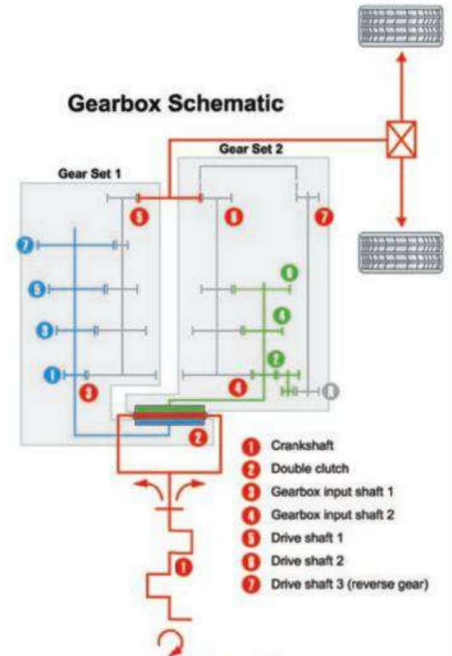


- | | |
|---|--|
| 1 Drive ring with pressure plate for K1 | 6 Lever spring with self-adjusting device for K2 |
| 2 Clutch disc K1 | 7 Clutch cover with self-adjusting device for K1 |
| 3 Central plate | 8 Lever spring K1 |
| 4 Clutch disc K2 | 9 Retaining ring |
| 5 Pressure plate K2 | 10 Stop ring |

Dry Double Clutch



- | | |
|---------------------|---|
| 1 Crankshaft | 6 Engagement bearing K2 |
| 2 DMF | 10 Engagement bearing K1 |
| 3 Central plate | 11 Gearbox input shaft 1 (solid shaft) |
| 4 Support bearing | 12 Gearbox input shaft 2 (hollow shaft) |
| 5 Pressure plate K1 | 13 Retaining ring |
| 6 Clutch disc K1 | 14 Diaphragm spring K2 |
| 7 Pressure plate K2 | 15 Diaphragm spring K1 |
| 8 Clutch disc K2 | |



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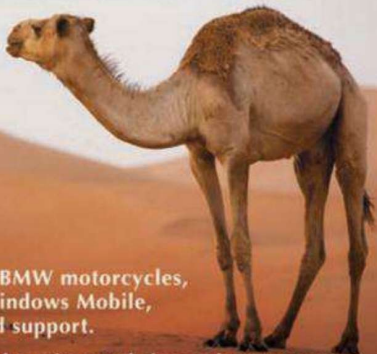
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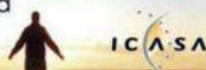
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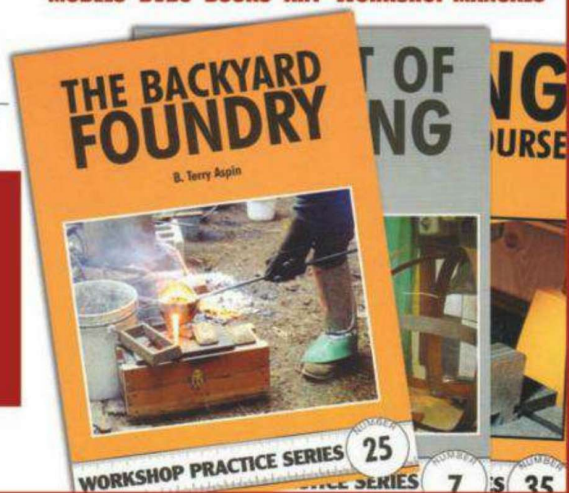


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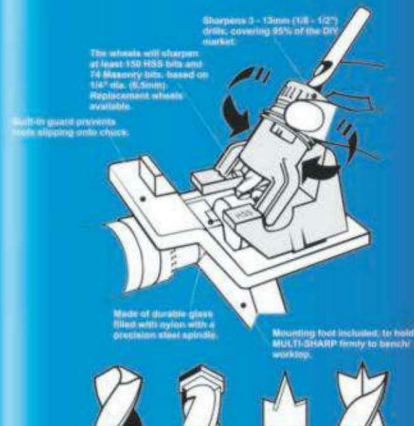
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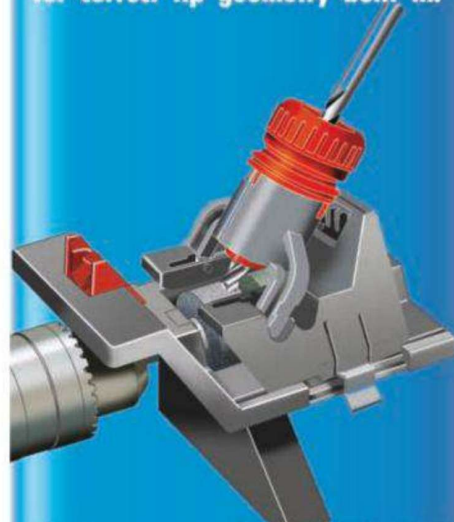
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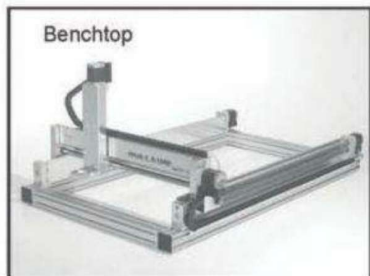
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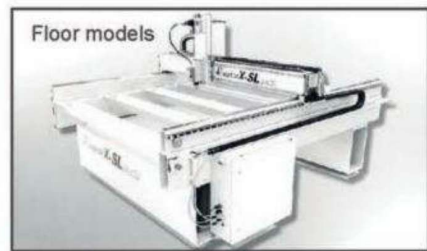
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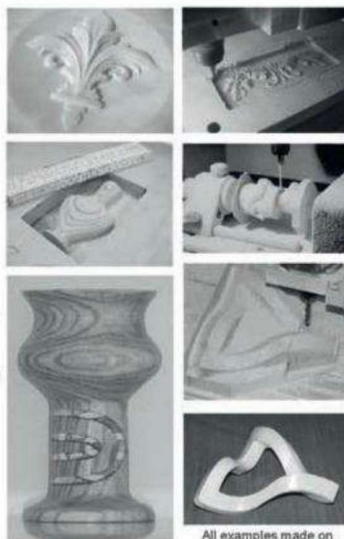
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KEEP IT CLEAN

When working with glass fibre, rather than using thinners to clean your brushes and other tools, try washing powder. It works well and is less expensive, less smelly and less toxic than thinners. I always keep a bucket of washing suds handy and drop my brushes into it when I'm finished. I'm saving a fortune on brushes.

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SIMON'S TOWN

Get a grip

If your magnetised screwdriver has begun to lose its grip on screws, try this: remove the permanent magnet from an old car speaker (the stronger the magnet, the better) and stroke the screwdriver across the magnet 10-15 times to re-magnetise the tip.

JP VAN EEDEN
HARRISMITH

Child's play

If you've ever struggled to squeeze that last bit of air from your child's inflatable boat or splash pool at the end of summer, you might like this hint. Insert a short length of thin plastic tubing into the valve opening so that it stays open – about 20-30 mm should do the trick. Now you can roll up the inflatable, confident that it will once again fit into its ridiculously tiny original packaging.

GREG DUFFETT
MUIZENBERG

Protect your car

Pressing the wrong button on the remote and closing the motorised driveway gate before your car is out of the way could result in an expensive – and embarrassing – repair job (it's happened to me). Here's how to reduce the risk of damage. First, buy a roll of thick and fairly wide adhesive-backed weatherstripping. Next, clean any loose rust, grease and dirt from the leading edge of the gate and apply the stripping all the way down the cleaned edge (this is to cater for combis and SUVs).

Apply a second layer of weatherstripping, sticking the second directly on top of the first layer. Now, if the gate is accidentally closed on a vehicle, the paint won't be scratched, and you might even avoid a dent – the padding absorbs the

shock while the collision-detection mechanism kicks in and stops the gate.

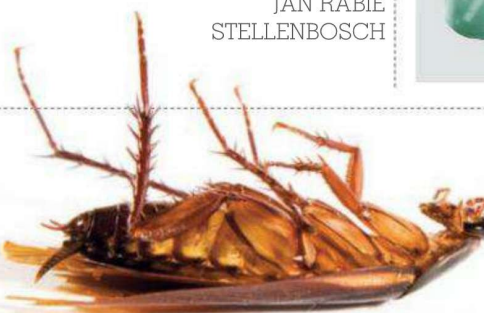
CHRIS GRAHAM
RANDBURG

On the level

When you buy tall wooden chairs for a bar or breakfast counter, the seats are sometimes too high, and you need to trim the legs to achieve the required height. Often, however, the legs are curved, making it difficult to trim them to exactly the same length so that they stand level.

Here's how to do it. First, determine the amount that has come off, then place each leg in turn in a bucket and fill with water to a depth corresponding to the required cut-off. Mark the cutting line by following the water line (this line will be 100 per cent horizontal). Repeat with each chair, preferably with the legs clamped in a vice. Easy!

JAN RABIE
STELLENBOSCH



Zap those roaches

Here is a cheap and effective method for killing cockroaches (for the record, we all have a problem with these pests at some time or another). Buy boric acid powder (also called boric acid, and not to be confused with borax) from your local chemist and combine with two boiled eggs to make small balls. Place these under cupboards, under large appliances and in all the other weird places that cockroaches live, keeping them away from children and pets. Within two weeks, you should be roach-less.

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